THE AMERICAN GAS LIGHT JOURNAL

PUBLISHING OFFICE No. 42 PINE STREET

DEVOTED TO THE INTERESTS OF ILLUMINATION HEATING, MECHANICAL, CHEMICAL AND GENERAL SCIENCE.

VOLUME LXXXVIII., No. 6. Whole No. 1,705. | NEW YORK, MONDAY, FEBRUARY 10, 1908. | $3 PER ANNUM, IN ADVANCE.

A. M. CALLENDER & CO., Proprietors. THOMAS J. CUNNINGHAM, ELBERT P. CALLENDER. } Editors.

ENTERED AT THE POST OFFICE AT NEW YORK, N. Y., AS SECOND-CLASS MATTER.

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[OFFICIAL NOTICE.]

Thirty-eighth Annual Meeting, New England Association of Gas Engineers.

NEW ENGLAND ASSOCIATION OF GAS ENGINEERS,
OFFICE OF SECRETARY,
EAST BOSTON, MASS., Feb. 5, 1908.

To the Members of the New England Association of Gas Engineers:

The Thirty-eighth Annual Meeting of the New England Association of Gas Engineers will be held in Young's Hotel, Boston, Wednesday and Thursday, February 19 and 20, 1908. The following papers will be presented:

"The Readiness to Serve Costs of Gas Supply," by Mr. Wm. H. Gardiner, New York.

"Re-enforced Concrete Oil Tank Building: Design, Construction and Cost," by Mr. Chas. F. Leonard, Fall River, Mass.

"Maintaining Mantle Lights," by Mr. N. W. Gifford, E. Boston, Mass.

"Filling Balloons with Coal Gas," by Mr. H. C. Crafts, Pittsfield, Mass.

"Report of Committee on Actual Accounting and Depreciation."

Questions.—"What new and successful devices are being used to extend the gas business?" "How has benzol enrichment withstood low temperatures in New England?" "How can breeze and other low burning fuels best be burnt?" "What has experience to date shown to be the comparative merits of Inclines, Machine-operated, Double-ended, and Vertical retort systems?" "What is the net result of the increasing use of pilot lights?"

Members having suggestions or questions which they wish discussed at the meeting will please forward them at once to the Secretary. Applications for membership should be sent to the Secretary as soon as possible, and should be accompanied by the initiation fee.

Members will dine together as usual, Wednesday evening, at 6:30 P.M. Friends of the Association are cordially invited to attend the meeting whether receiving formal invitation or not.

N. W. GIFFORD, Secretary.

BRIEFLY TOLD.

THE BROADENING OF STEVENS INSTITUTE.—While other homes of teaching may perhaps have their names sounded oftener in the public ear than the Stevens Institute of Technology, it is nevertheless a fact that none other (unless that one be the Ann Arbor University, through its well-maintained Gas Scholarship, at the instance of the Michigan Gas Association) is oftener in the minds of gas men. Its first President—the thoughtful, sympathetic, lovable Dr. Morton—was known to gas men wherever gas works were, and its present President (Dr. A. C. Humphreys) is surely known to gas men equally well. And in furthermore of its standing amongst the fraternity it may be noted that two score or more of its graduates are now in various ways practically connected with the industry, chiefly in the engineering division, with quite a brood of youngsters in training for like duties when the Institute shall have said your tuition is at an end, so far as books and tutors go. This introductory reciting all comes through the receipt of a word or more from Prof. Albert F. Ganz, whose lecture before the American Gas Institute in Washington last October, on "Electrolysis" will long be remembered, respecting the following list of special lectures on practical subjects that were delivered to the Senior Class of Stevens during the month of January: "Manufacture of Illuminating Gas," by President A. C. Humphreys; "Electrolysis from Stray Railway Currents," by Prof. A. F. Ganz; and "Recent Developments in the Generation and Distribution of Electric Light and Power," by John W. Lieb, Jr., who has many titles, but whose designation as Third Vice-President and Associate General Manager, the New York Edison Company, is surely sufficient to prove his capacity for fully treating the subject that he elected for expounding. Other interesting lectures were given, of course, but these are named to show that Stevens keeps quite awake to matters intimately connected with the business of the gas maker. Perhaps we are not so very far from a set course of gas engineering in Stevens as the present would suggest.

DEATH OF MR. CHARLES H. GIFFORD.—Mr. Charles H. Gifford, who was prominent in the political activities of Massachusetts for over two score years, died at his home in New Bedford, Mass., the morning of the 3d inst. He was in his 75th year, and will be remembered by gas men through his service as a member of the Massachusetts Board of Gas and Electric Light Commissioners, covering a 9-year term—from 1894 to 1903.

CURRENT COMMENT.—

AT the last meeting of the Board of Trustees of Stevens Institute of Technology, Dr. Edward Weston was unanimously elected a permanent member of the Board. This is as it should be, for the Doctor has always been actively concerned in any development that was of interest to the Institute. It is, however, not the first time that Stevens has honored Doctor Weston: for it was that Institute which, in 1904, conferred upon him the honorary degree of Doctor of Science.

THIS mention of Stevens and Doctor Weston recalls to mind that the Seventh Annual Dinner of the Stevens Alumni was partaken of in the Hotel Astor, New York, the evening of the 4th inst. About 250

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Stevens men and their guests shared the proceedings. The participants, apart from completely enjoying a college dinner and a personal reunion, heard some notable addresses. That the word "notable" is not other than properly used may be readily understood by a glance over the following listing: President A. C. Humphreys; Dr. H. S. Pritchett, President of the Carnegie Foundation for the Advancement of Teaching: Prof. George V. Wendell; Hon. Robert P. Porter, formerly Chief of the Census Bureau, but now representing the *Times*, of London, England, in America; Colonel George Harvey, Ernest H. Peabody and H. V. R. Scheel.

It is said that last year the output of different appliances for using gas as fuel by the Consolidated Gas, Electric Light and Power Company, Baltimore, Md., amounted to 10,000 separate pieces, involving an expenditure of well on to $100,000.

Dr. J. B. King and Mr. C. D. Hamilton, both prominent residents of Banning, Cal., are arranging for the construction there of a gas plant.

"Although Mr. Thos. D. Miller managed to become a pretty sick man through a violent attack of 'an old-fashioned cold'—so he terms it—when in New York last January, during the meeting of the National Commercial Gas Association, it does not seem to have interfered any with his powers as a diplomat. The last night of last month, when the day and night crews of the New Orleans Lighting Company were changing shifts, some of the men refused to go on, and things looked squally or worse for a while. Word was sent to Mr. Miller, and, however he managed it, after a short conference, the crew set up a cheer and assumed their respective duties. In this connection it may be said that a good deal of unrest is being shown by the workingmen of the Southwest.—F. T. R."

We regret very much to have to report the death of Mr. William J. Seaton, Jr., Second Vice-President of the C. W. Hunt Company, West New Brighton, New York, who passed away at his home in Clifton, Staten Island, on January 18th. Typhoid fever was the illness from which he suffered, and death claimed him at the all too youthful age of 36. Mr. Seaton entered the employment of the C. W. Hunt Company in 1891, as an office boy, but his exceptional abilities speedily gained for him the recognition which they deserved, and promotion followed promotion right up to the time of his death. His name was associated with many of the large contracts carried out by the Company in recent years.

The increase of gas output by the Chickasha (Okla.) Gas Company, which has been in operation less than 3 years, is returned at 55 per cent., as between 1906 and 1907. That seems to be going rather speedily.

The gas and electric lighting plants at Valparaiso, Ind., have been sold by the Geist syndicate to a corporation, the executive head of which is Mr. C. B. Kelsey, of Grand Rapids, Mich.

New Executive Management, Riter-Conley Manufacturing Company.

The following matter, respecting the new staff of the Riter-Conley Manufacturing Company, of Pittsburgh, Pa., is official:

At a special meeting of the Company, held in its home offices the 22d ult., these gentlemen handed in their resignations: Vice-President W.C. Coffin; Gen. Manager, R.A. McKean; Secretary and Treasurer, J. S. Craig; Purchasing Agent, H. M. Wilson. The resignations having been accepted, the following gentlemen were named to fill the vacancies: Vice-President, J. Gilmore Fletcher; Treasurer, W. L. Jack; Secretary, Joseph Riter; Purchasing Agent, Fred. Wulfetang; Assistant Treasurer, F. R. Sites. Mr. H. A. Carpenter, who was elected President of the corporation at its annual meeting last November, has also been chosen General Manager, and he will have as assistant in this position the Company's Secretary, Mr. Joseph Riter. Mr. Sites, the Assistant Treasurer, was formerly assistant to Mr. Carpenter, while the latter was Chief Engineer of its gas department.

Mr. F. M. Bowman remains Engineer-in-Charge of the structural department, which position he has held for some years past. His assistant, J. T. Donaldson, has been advanced to the position of chief of the general bureau of estimating. W. B. Osborne, who has been with the Company for the past 10 years, has been made Chief Engineer of the gas department, the position held by Mr. Carpenter prior to his election as president. Thomas Rodman, who has been with the concern since he graduated from Yale in 1896, has been promoted from the position of General Manager of the Leetsdale plant and shops to Engineer in charge of sales.

President Carpenter graduated from Yale in 1891, and entered the employ of the Riter-Conley Mfg. Co., in 1896, when he started the gas department, of which he was placed in full charge. He built up this branch of the business successfully and he ranks with the leaders in gas construction work. He was also a prominent figure in the building of the Leetsdale plant, having had more to do with its construction and equipment than anyone else. He designed the shops and equipment, and superintended their construction, and these shops for completeness and modernity are not surpassed by any other of current time.

[Continued from page 187.]

PROCEEDINGS AMERICAN GAS INSTITUTE, SECOND ANNUAL MEETING, HELD AT THE NEW WILLARD HOTEL, WASHINGTON, D. C., OCTOBER 16, 17 AND 18, 1907.

Third Day—Morning Session.

The President—The next paper in order would be the paper by Mr. W. A. Baehr, of St. Louis, Mo. I understand he is not here. What, if any, action will you take?

Mr. Cowdery—I understand that Mr. Baehr was obliged to go to St. Louis yesterday on account of arrangements necessary for him to make in connection with the balloon ascensions which are to take place there soon. I, therefore, move that the paper by Mr. Baehr be not taken up, but that like all papers which may need revision by the "Publication Committee" it be referred to that Committee, and that it appear in the Proceedings, and that any discussion on the paper may be put in writing and sent to the Secretary for insertion in the Proceedings in a like manner. [Seconded.]

The President—Gentlemen, you have heard the motion. Are there any remarks?

Mr. A. E. Forstall—Should there not be some limit of time within which discussion on Mr. Baehr's paper will be accepted?

The President—Yes; but I think that would be a difficult thing to settle. The discussion, of course, will have to be in before the publication of the Proceedings.

Mr. A. E. Forstall—I suggest that, if such discussion is not in within 3 weeks, it be understood that it is not to be included.

The President—Do you make that as an amendment to Mr. Cowdery's motion?

Mr. A. E. Forstall—If Mr. Cowdery has no objection, that can be included.

Mr. Cowdery—That is agreeable to me.

The President—You have heard the motion. Those in favor please say "Aye." Contrary minds "No." [Carried.]

A BULLETIN OF INSTRUCTIONS ON THE CARE AND OPERATION OF RECUPERATIVE BENCHES,

by Mr. W. A. Baehr, St. Louis, Mo.

When I was requested to write this paper by President Walton Clark he expressed a desire that I should deduce a set of rules, for the care and operation of recuperative benches, which should be so concise and simple that any retort house foreman should be able to readily understand and follow them. I will endeavor to do this, and formulate such instructions at the end of this paper. Prior to doing so, however, it appears desirable that some of the elementary principles of recuperative bench construction and operation, as well as of thermochemical actions and reactions, should be presented, and an effort made to harmonize a number of existing conditions in regard to a rational method of rating benches; also, as to definitions of styles of construction and names of parts. It also appears highly desirable to endeavor to exhibit a table of data regarding actual results obtained in practice in the more or less representative gas plants of this country, in order that a person might readily refer thereto, and thereby compare the outcome of his efforts for improvement with those actually accomplished elsewhere.

No attempt will be made in this paper to compare horizontal, inclined and vertical retort construction, nor will I endeavor to cover the operation of the two latter types. Appended is a list of references which were consulted during the preparation of this paper.

Recuperative or Regenerative, Reverberatory.—A great deal of confusion exists as to whether gas benches as ordinarily built are of recuperative or of regenerative construction. We should inquire into this matter and see if the question cannot be determined. The "Century Dictionary and Cyclopedia" supplies us with the following definitions:

Recuperate. v.—To recover; regain.

Recuperator, n.—1. One who or that which recuperates, or recovers.

2. That part of the Ponsard furnace which answers the same purpose as the regenerator of the Siemens regeneration furnace. See regenerator.

Regenerate. v.—1. To generate or produce anew; reproduce.

Regenerative. a.—1. Producing regeneration; renewing.

2. In metallurgy, on the principle of the Siemens regenerator, or so constructed as to utilize that method of economizing fuel, as in the term regenerative gas furnace. See regenerator.

Regenerative Burner.—In gas lighting, a device by which the current of gas is heated before it reaches the flame, thus making combustion more complete.

Regenerative Furnace.—A furnace in which the waste heat of the the products of combustion is utilized by being transferred to either the air or the combustible gases, or both, entering the furnace. This transfer is effected by means of so-called "regenerators."

Regenerator. n.—2. In metallurgy, a chamber filled with a checkerwork of firebricks; that part of a regenerative furnace in which the waste heat of the gases escaping from the hearth is, by reversal of the draft at suitable intervals, alternately stored up and given out to the gas and air entering the furnace. The idea of employing what is now generally called the "regenerative system" of heating was first conceived by Robert Stirling, in 1816, but his arrangement for carrying it out was not a practical one. The present form of the furnace, and in general the successful application of the principle, constituting a highly important improvement in the consumption of fuel, are due to the brothers Siemens. The regenerative system has already been extensively applied to various metallurgical and manufacturing processes, and is likely to receive still further development. According to the Siemens regenerative method, there must be at least one pair of regenerative chambers, in order that the heat may be in process of being stored up in one while being utilized in the other. In the Siemens regenerative reheating, or mill furnace, there are two pairs of chambers, each pair consisting of one larger and one smaller chamber, through one of which the air passes, and through the other the gas on its way to the furnace. The so-called "Ponsard recuperator" is a form of regenerator in which, by an ingenious arrangement of solid and hollow firebricks, the current is made continuous in one direction, instead of requiring reversal as in the Siemens regenerative furnace. This form of furnace has been employed for reheating in rolling mills.

Reverberate, v.—1. To beat back; repel; repulse.

3. To turn back; drive back; bend back; reflect; as reverberate rays of light or heat.

4. Specifically, to deflect (flame or heat) as in a reverberatory furnace.

Reverberatory Furnace.—A furnace in which the fuel is not brought directly in contact with the material to be acted on by the fire, but which is so arranged that the flame of the burning gases plays over or is "reverberated" upon the ore or metal under treatment.

The "Standard Dictionary," Nelson's "Encyclopedia," and Knight's "American Mechanical Dictionary" give definitions of "regenerator" and "regenerating furnace," which are not as complete as those of the "Century Dictionary," but which bring out the idea of the reversal of flow. The following extract from the "Encyclopedia Britannica" serves to confirm the essential principles of a reverberatory furnace:

"*Reverberatory Furnace.*—Blast furnaces are, from the intimate contact between the burden to be smelted and the fuel, the least wasteful of heat; but their use supposes the possibility of obtaining fuel of good quality and free from sulphur or other substances likely to deteriorate the metal produced. In all cases, therefore, where it is desired to do the work out of contact with the solid fuel, the operation of burning or heat-producing must be performed in a special fireplace or combustion chamber, the body of flame and heated gas being afterwards made to act upon the surface of the material exposed in a broad, thin layer in the working bed or laboratory of the furnace by reverberation from the low-vaulted roof covering the bed. Such furnaces are known by the general name of reverberatory or reverbatory furnaces; also as air or wind furnaces, to distinguish them from those worked with compressed air or blast."

I believe these definitions of a reverberatory furnace, as covered in the "Century Dictionary" and "Encyclopedia Britannica," are so clear, and make that type of furnace so distinctive from a recuperative or a regenerative furnace, that we can drop the word reverberatory as being not apposite to the gas business in the sense in which we are connected with it, viz., gas used for city distribution. And this seems to justify dropping a further discussion of this word and of this type of construction.

Not so, however, with the words recuperative and regenerative. Referring for a moment to "Die Gaserzeuger und Gasfeurungen," by Ernst Schmatolla, Edition 1901, pp. 66, 67 and 68, we find a general description of regenerators. In general his description comprises a chamber or set of chambers filled with firebrick, through which the hot waste gases are passed until the checkerwork of firebrick is heated, it being understood that this passage of gases takes place in one continuous direction during this heating process. After the regenerative chamber has attained a suitably high temperature, the flow of the hot gases through it is stopped, and gas or air is admitted into this chamber and flows through it in the opposite direction from that of the hot waste gases, and in this manner the air or gas is preheated. The process is described distinctly as an intermittent one, and the idea of reversal in direction of the hot waste gases, and the air or gas to be preheated, are also clearly brought forth.

We have still another reference on this question in the "Lehrbuch der Chemischen Technologie der Energien," by Prof. Hans v. Juptner. This book of Juptner's constitutes one of the most authoritative, as well as one of the most recent publications on these subjects, not only in Germany but in the scientific world. Referring to the 1906 Edition, Book I., Part 2, we find several clear and distinct definitions or ideas on the word "recuperative and "regenerative." Here are some of these distinctions as set forth in Juptner's work:

Page 60.—"Recuperators" are defined as "preheaters." "Regenerators" are defined as "storage places of heat."

Page 105.—In the chapter describing "Kinds of Heat Producers," Juptner states as follows:

"'Regenerators,' or storage places of heat, are so called because the material receiving the heat (checkerwork of firebrick) gathers this heat from the products of combustion for a given period of time, in order to give it out again later on to the substance to be heated."

Page 135.—In Chapter XIV., Juptner treats of "Recuperators, Regenerators and Air Heaters," and here a further distinction of the words under discussion is introduced. Here these styles of construction have certain additional distinctive features added as follows: "Recuperators" are styled as those subject to continuous operation, while "regenerators" are stated as those subject to intermittent operation.

As I have already gone into this part of the subject at length, I simply wish to add another line of thought concerning it which is offered by Mr. J. M. Rusby, of the United Gas Improvement Company, Philadelphia. The following extract from a letter I received from Mr, Rusby, under date of July 17, 1907, covers the points he brings forth:

"To regenerate means to develop. Thus apparently referring to sensible heat (in which form all waste heat is recovered in recuperation), its re-development from the latent heat of steam by condensation might be considered a regenerative process; also, its development from the latent heat of combustion of producer gas by burning is such; also (see 'Gas and Gas Making,' 'Encyclopedia [Americana),' a deep furnace which makes producer gas for subsequent burning at another part of the setting, is properly called a regenerative furnace.

"From the foregoing, does it not rather seem that both the recuperative constant flow flues of the coal gas bench, and also the brick-filled Siemens' stove, should both be called recuperators, the word regenerative being reserved to only apply to furnaces which make producer gas with its stored latent heat of combustion or regeneration of sensible heat; but is this occasional fact a warrant for giving it another name than recuperator? Since the words regeneration and recuperation have no relation whatever, it being possible for a furnace to possess one without the other, it seems that they should be kept carefully separate.

"The Siemens' stove might be called an intermittent recuperator, and the flues of the coal gas bench a continuous recuperator; more appropriate titles may suggest themselves to you.

"Present usage, however, even by the best writers, is not in entire conformity with the foregoing. In many cases, as you state, there is no effort at even consistency. One of the most careful writers whom we have happened to find (see Damour's 'Industrial Furnaces,' 1906, published by the *Engineering and Mining Journal*, New York city), appears to use these terms about as you suggest; thus, while he in his general treatment calls both the Siemens' stove and the coal gas bench flues recuperators, he nevertheless thereafter practically separates them and calls the Siemens stove a regenerator (p. 238). He also alludes (p. 116) to the receiving of carbon dioxide by a furnace, and its conversion thereby into combustible carbon monoxide, etc., as a so-called regenerative process; as to his precise practical use of this term regenerative, I must refer you to his book."

From the foregoing it appears that I may suggest the following definitions of the words "recuperative" and "regenerative," as applied to ceal gas benches, and it is, of course, open to question as to

whether the profession in general sees fit to adopt them. I wish to add, however, that the line of thought suggested by Mr. Rusby is very pertinent, and probably, in the strictest interpretation of the words and their meaning, he is correct. Owing, however, to the almost universal adoption of the word "regenerative," as describing the Siemens furnace, by the most careful and authoritative technical writers at home as well as abroad, I would hesitate to reject this meaning as being the incorrect one in the field of technology, whatever may be the etymological one.

Recuperative Bench.—A recuperative bench is one in which one of the essential parts is a recuperator, or set of recuperators; whose function is the preheating of some substance, usually air, whether that be primary or secondary air, or both; such preheating being accomplished by continuous operation, in one direction of passage of the substance to be heated through a flue, or set of flues, and without reversal of direction, and without a transposition from one flue or set of flues to another flue or set of flues. The latter phase of the definition practically forces the additional statements that the transfer of heat takes place through the walls of the flue or flues, which walls in no sense of the word are to be considered as storing up heat, and the substance supplying the heat must in consequence be separated from the substance to be heated by the walls referred to, and in its turn must have one direction of passage through the flue or flues, and must not be transposed from one flue or set of flues to another. This might properly be called a continuous recuperator.

Regenerative Furnace.—A regenerative furnace, in the technical sense of the word, is one in which one of the essential parts is a flue or chamber, or set of chambers, which is used for the preheating of some substance, usually gas or air, or both; such preheating being accomplished by distinctly intermittent operation; the substance to be heated passing through such a chamber, or set of chambers, for a limited period of time; after which it is transposed to another chamber or set of chambers; the first chamber, or set of chambers, then having the substance supplying the heat introduced into it, for the purpose of storing up heat; after which the substance to be heated is again transposed into the first chamber or set of chambers, for the purpose of taking up the stored heat, and so on *ad infinitum*. One of the essential ideas is a distinct storing up of heat; another is the giving out, and absorbing of such heat by convection and radiation of such heat, and not by transmission of the heat through any substance, such as walls of flues. It follows, therefore, that the substance giving out and the substance receiving the heat cannot occupy one chamber, or set of chambers at the same time. I cannot find that the reversal of flow is necessary to the technical correct understanding of the term, but such reversal of direction of flow of the two substances would probably be employed. This might more strictly be called an intermittent recuperator.

I will enter a plea right here that writers on these subjects be very careful of the terms they use, and if still better definitions are devised than the foregoing, so much the better for all of us.

A Rational Method of Rating or Classifying Recuperative Benches, Particularly as to Depth of Fire and Amount of Recuperation.—It has become customary among us all and among the manufacturers to speak of half, three-quarters and full-depth recuperative benches, and it appears to me to be highly desirable to discard such terms, which upon close analysis cannot be supported by good reason and argument, adopting in their stead some rational method of rating benches which will satisfactorily and logically fill all requirements. In a paper I wrote for the Ohio Gas Light Association (1903 meeting) I offered the following definitions of certain so-called types of benches:

"A full-depth recuperative bench is one in which both the primary and the secondary air is preheated.

"A half-depth recuperative bench is one in which the secondary air only is preheated."

I wish to state that these definitions now appear to me erroneous, and I wish to retract them right here. To start with, it is easy to see how two manufacturers, for instance, could be bidding on a certain job of, say, so-called half-depth benches. Both might offer the same number and size of retorts, iron work and all that, but one might put in recuperators down to the level of the foundation, while another might stop them 2 feet above the grates. Both would be bidding on half-depth benches, but the competition would be wholly unfair, unless due allowance was made for this discrepancy. It appears essential to state the primary objects to be accomplished in the design and construction of a recuperative bench. As I see them, these objects are:

1. To completely carbonize the maximum quantity of coal in the effective length of the retorts in the shortest possible period of time.
2. To do this with the least possible cost (such as for bench fuel, labor, etc.).

The above considerations lead us to first consider the retort itself. Here we should endeavor to be able to properly carbonize as much coal as possible per unit of effective length of the retort in the shortest possible time. This, of course, requires a certain number of heat units per unit of time, and this in turn necessitates a certain producer gas capacity. Omitting for the moment the gas producer portion of the argument, I will try to show that there should be a certain recuperation capacity per unit of effective retort contents in any given recuperative bench.

Relation of Effective Retort Contents to Recuperation.—The greater the amount of coal carbonized per unit of effective retort contents, the greater is the amount of a given quality of producer gas that must be burned in a given length of time, and this necessitates in turn a greater recuperation capacity. This statement appears to me to be true, and from it there follows the conviction that there is probably an economical relation between effective retort capacity and effective recuperation capacity. Now, how should this relation be expressed?

It first occurred to me that the effective retort capacity should be the proper expression to use, but this may lead to erroneous conclusions, inasmuch as the shape of a retort may alter the relation of the interior surface to the cubical contents. It appears, therefore, that it would be wiser if we used both the effective cubical contents, and effective interior surface of the retorts, and expressed their relations to the effective recuperation surface. It appears to be somewhat puzzling to select the effective recuperation surface, but after study I would suggest that that surface of the recuperators which is in contact with the hot waste gases, and which has the incoming air on the opposite side of the wall, be adopted. In other words, I would not consider as effective the portion of the recuperator surface which touches the wall of the arch of the bench, nor any such surface which does not transmit heat directly through the material to the incoming, passing air on the other side of it. This may not be exactly the truest expression of effective recuperator surface, inasmuch as heat is undoubtedly transmitted through the walls in other directions than perpendicular to the surface of the wall; but by adhering to the method I have suggested, it will have the merit of uniformity, and will always enable comparisons to be made. I will use it thus in this discussion.

If, then, when we order or design benches, we will specify the relation between effective retort contents, effective interior retort surface, and effective recuperation surface, we should certainly be enabled to secure at least honest competition, and eventually we will find what is the economical relation between these qualities.

In as far as effective retort contents and effective interior surface of retorts are concerned, I will simply state my ideas on these points in connection with ordinary horizontal retorts. I would figure the effective portion of a retort as beginning at the interior of the front wall of the bench, and extending on the inside up to the joint between the back and the body of the retort. This omits figuring the back entirely, as it is usually bricked up solidly against the rear wall of the bench, and also omits that portion of the front end projecting into the front wall of the bench. The figuring of a through retort, or of vertical or inclined retorts, would be considered on a similar basis, but will not be treated in this paper.

I am unable to state just what these relations should be at this writing, but have certain data regarding current practice which I herewith present. One company prominent in the manufacture of firebrick products in the United States, that builds many benches every year, kindly gave me these plans and figures on various types of benches, as follows:

So-Called Half-Depth Bench of Six Retorts.

Retorts, 16 inches by 28 inches by 9 feet.
Effective length retorts 7 feet 9 inches.
" interior surface per retort, 6,441 square inches.
" " " " 6 retorts, 38,646 square inches.
" cubical contents per retort, 31,577 cubic inches.
" " " " 6 retorts, 189,462 cubic inches.
" recuperation surface, 16,034 square inches.

Ratio of effective recuperation surface to effective interior surface of all 6 retorts, 41.5 per cent.; ratio of effective recuperation surface in square inches to effective cubical contents of all 6 retorts in cubic inches, 8.46 per cent.

So-Called ¾-Depth Bench of Six Retorts.

Retorts, 16 inches by 28 inches by 9 feet.
Effective length retorts, 7 feet 9 inches.
" interior surface per retort, 6,441 square inches.
" " " " 6 retorts, 38,646 square inches.
" cubical contents per retort, 31,577 cubic inches.
" " " " 6 retorts, 189,462 cubic inches.
" recuperation surface, 22,287 square inches.

Ratio of effective recuperation surface to effective interior surface of all 6 retorts, 57.7 per cent.; ratio of effective recuperation surface in square inches to effective cubical contents of all 6 retorts in cubic inches, 11.75 per cent.

So-Called Full-Depth Bench of Six Retorts.

Retorts, 16 inches by 28 inches by 9 feet.
Effective length retorts, 7 feet 9 inches.
" interior surface per retort, 6,441 square inches.
" " " " 6 retorts, 38,646 square inches.
" cubical contents per retort, 31,577 cubic inches.
" " " " 6 retorts, 189,462 cubic inches.
Effective recuperation surface, 32,174 square inches.

Ratio of effective recuperation surface to effective interior surface of all 6 retorts, 83.2 per cent.; ratio of effective recuperation surface in square inches to effective cubical contents of all 6 retorts in cubic inches, 17 per cent.

So-Called Full-Depth Bench of Nine Retorts.

This particular bench contains 6 retorts, 16 inches by 28 inches by 9 feet 4½ inches, and 3 retorts 16 inches by 26 inches by 9 feet 4½ inches. Effective length of all retorts, 8 feet 1½ inches.

Effective interior surface of retorts is as follows:

Size, 16 inches by 28 inches by 8 feet 1½ inches = 6,753 square inches = 40,518 square inches for 6 retorts.

Size, 16 inches by 26 inches by 8 feet 1½ inches = 6,490 square inches = 19,470 square inches for 3 retorts.

Total effective interior surface = 59,988 square inches for 9 retorts.

Effective cubical content of retorts is as follows:

Size, 16 inches by 28 inches by 8 feet 1½ inches = 33,005 cubic inches = 198,030 cubic inches for 6 retorts.

Size, 16 inches by 26 inches by 8 feet 1½ inches = 31,522 cubic inches = 94,566 cubic inches for 3 retorts. Total effective cubical contents = 292,596 cubic inches for 9 retorts. Effective recuperation surface = 32,174 square inches. Ratio of effective recuperation surface to effective interior surface of all 9 retorts, 53.5 per cent.; ratio of effective recuperation surface in square inches to effective cubical contents of all 9 retorts in cubic inches, 11 per cent.

These figures show nothing except an arbitrary relation. The extent to which recuperation is to be carried in order to secure the greatest commercial economy is, as far as I am able to determine, as yet unknown. I have knowledge, however, of recent installations in which I believe the recuperation has been applied to an extent never before attempted.

There is another aspect of recuperation which I wish to present for consideration, or rather a more forcible presentation of the reason or desirability for recuperation. I know of no better way to concisely and tersely present the matter than to quote from a letter I received from Mr. B. E. Chollar under date of July 15, 1907:

"*Recuperation.*—Let us suppose, for illustration, that one-fifth of the heat from the furnace is absorbed by the retorts, and another is enough for the chimney, there remain three-fifths for possible recuperation. Now, if an area equal to the retort surface takes one-fifth, the absorbing surface for the three-fifths to be recovered should be at least three times as much as the retort area. In other words, if the above supposition should happen to be right, the maximum recuperator surface should be about 3 times the retort area. This area is for only one set of flues. To get the total of radiating and absorbing surface this area should be doubled. This is just one way of looking at the question. It is not a recommendation to be carried to the limit."

I believe Mr. Chollar brings out this point very clearly, and in your own minds you can compare his illustration with the figures from the manufacturers' standard previously quoted. In some of my previous papers on this subject I referred to a paper written by Mr. Fred. Bredel, and read before the Western Gas Association, May, 1892, entitled, "The Advantages of Recuperative Furnaces in the Utilization of Heat."

I wish to again call attention to this paper. Almost all of the thermal calculations concerning standard recuperative bench operations are given therein; and, what is more, the variation of the specific heat of various gases at different temperatures is taken into consideration in the figures. Anyone who undertakes to delve into the mysteries of recuperative benches should study this excellent paper by Mr. Bredel, and he will find that Mr. Bredel had it all figured out very well long ago, and that a great many of the more recent efforts in this direction are not nearly as good as Mr. Bredel's.

This gentleman also read a paper before the Ohio Gas Light Association in the same year, viz., 1892, entitled, "The Determination and Regulation of the Proper Proportions of Primary and Secondary Air and Steam in Regenerative Furnaces." In this paper Mr. Bredel arrives at the conclusion that the waste gases on leaving a good recuperator should not have a higher temperature than 350° to 360° C., or 650° to 680° F. It may be that such figures are as good as we should strive to attain in commercial operation, but it looks to me as though there were some possibilities in carrying recuperation still further, even though the balance of the sensible heat which could be extracted from the waste gases was utilized in other ways than to preheat secondary air. I make this statement because the sensible heat in the waste gases is greater than can be taken up by the secondary air alone.

Before making any further reference to the proper amount of recuperation for any given retort installation, I will here outline the principal thermal considerations of a recuperative construction. Omitting the consideration of utilizing water or steam under the grates, and also losses by radiation, convection, opening of doors, ash, clinkers, etc., we have:

1. A given amount of fuel (say carbon), burns to CO_2, through a producer gas operation, and develops a certain high flame temperature A. The products of combustion, therefore, at first have a temperature A, and pass around the retorts to the entrance of the recuperator, where they have a lower temperature, B.

2. The amount of heat, therefore, required to heat the retorts (omitting all losses) is measured by the drop in temperature of the products of combustion from A to B, times the average specific heat of said gases between said temperatures.

3. The amount of available heat left in the products of combustion at the top of the recuperators is measured by the drop in temperature from B to atmospheric temperature C, times the mean or average specific heat of said gases between said temperatures B and C, again omitting all losses.

If we should assume C = 20° C. and B = 1,150° C., then the maximum available drop in temperature in the recuperators is 1,130° C. As the amount of waste gases is greatly in excess of the amount of secondary air, and also because of the greater thermal capacity, it appears to me impossible to utilize all of the available heat between the temperatures B and C for preheating the secondary air, and there are certain physical conditions which make an attempt at preheating the primary air to any great extent considerable of a question.

I must say the ideal way to construct benches appears to me to have separate, continuous gas producers serving a stack of benches, using as much of the sensible heat of the waste gases as possible for preheating the secondary air, and the balance might be applied for preheating the primary air, the fuel itself, or possibly in still other ways. I must also say that I am unable to give the commercially best amount of recuperation surface for preheating secondary air as related to any given retort installation, but am of the opinion that, if anything, we use too little rather than too much. I would also say the figures of the particular manufacturer I cited are such that I believe I would specify still greater percentages than those quoted. The whole art is still so indefinite that I believe we shall only gradually come to a correct understanding of the proper recuperator relations.

I will not endeavor to cover such practical considerations as sizes of flues, leakage between the waste gas and air flues, thickness of walls, change of direction of flues, etc., because these form special features of design which I did not intend to consider. For heat transmission through firebrick, see diagram by Mr. Fred. Bredel, page 137, Proceedings of Western Gas Association, 1892 to 1895, inclusive.

I believe that the functions of a recuperator can be outlined briefly as follows:

1. The length of time accorded to the waste gases to give off their heat.

2. The amount of heating surface, thickness of division walls, and as little friction loss as possible in the passage of the waste gases through the flues.

3. The heat accumulative capacity of the recuperator—that is, a heavy recuperator will act as a storage reservoir of heat, and cause less heat fluctuations than a light one.

Before leaving this portion of the subject entirely I wish to insert some valuable comparative data kindly furnished me by Mr. A. H.

Strecker, Engineer, the Public Service Corporation of New Jersey, concerning full-depth benches. Mr. Strecker figures recuperation surface just as I do, but figures the effective length of a retort from the face to the inside of the back, which I think is a little liable to confusion. He does not include the back of the retort, however.

Data by Mr. Strecker.

Type of Furnace.	Heating Surf. or Recup. in Square Inches.	Ratio of Recup. Surf. to Surf. of Retorts.
Klöenne.....	30,720	33.9 per cent.
Parker-Russell	30,240	33.3 "
Newark	37,152	41.1 "
Average.....	32,704	36.1 "

The recuperators cited in these figures occupy practically the whole space between exit flues which are situated on basement floor level, and are about 9 feet high. He states the lower smoke flue temperature runs from 500° F. to 600° F. In the Klönne Newark (N. J.) benches the heat of the flue gases is made further use of to evaporate water in the ash pan.

Depth; Grate Area.—The actual depth of the furnace and of the fire is another matter closely related to a proper bench design. Since I am attempting to discuss recuperative benches only, all matters relating to free-fire benches will be omitted. The fundamental idea of the furnace is simply that it is a gas producer, and usually air and some water vapor are admitted under the fire. The oxygen of the air and of the water appears above the fire, combined with carbon in the form of carbon monoxide, the hydrogen of the water as hydrogen, while the nitrogen of the air passes through unchanged. I will discuss these reactions a little later on in the paper; and, for the purposes of this immediate discussion, it is only a question of a few general principles which are involved.

In general the elementary principles governing the shape of a producer have been enumerated in my paper before the Ohio Gas Light Association in 1903. A producer ought theoretically to be circular in cross section, because the circle is that geometrical figure which has the greatest area for the least length of developing line. On account of practical considerations a rectangular cross section is usually adopted, and this in turn should be as wide as possible, or, in other words, approach a square cross section, for the reason that a square is the geometrical rectangular figure which has the least perimeter for a given area, less than any rectangle. Under a bench a rectangular producer cross section is practically necessary, but for separately fired producers I most emphatically state that a circular cross section should be the best or at least a square one.

Now, the thermo-chemical functions which a gas producer is called upon to fulfill require for one thing a minimum depth of fire. The question of velocity, or what is the same thing, the question of the finite length of time required to produce the reactions mentioned, will be omitted for the moment. It seems to be the general opinion that a minimum fire-depth of about 3 feet under reasonable velocity conditions will allow these reactions to take place. As authority for such a statement I quote:[1]

"See Schmatolla, 'Die Gaserzeuger und Gasfeurungen.' Certain of our fireclay products manufacturers evidently believe that even a slightly less depth than 3 feet might be satisfactory. I believe, however, that deeper fires would be preferable, although they might be somewhat difficult to secure in the so-called half-depth benches."

In regard to the question of depth, I will quote in full from a letter I received from Mr. Roger W. Polk, of St. Louis, under date of July 2, 1907, as follows:

"The terms (referring to half-depth, etc.) adopted by the bench manufacturers would be all rightif they would all use a certain height of arch for a certain form of bench. For instance, I consider a ½-depth bench one in which the distance from the grate bars to the crown of the furnace arch is 36 inches; a ¾-depth bench one in which this same dimension is 54 inches, and a full depth bench 72 inches. These are absolute measurements, and the ¾-depth bench is exactly half way between a half-depth and a full-depth bench. It is understood, of course, that the recuperators go down to a level with the top of the ash pan in all cases, otherwise you might have a ½-depth recuperator with a full-depth furnace.

"It would not be necessary to take the measurement from the grate bars to the furnace arch, but if manufacturers would take some similar dimension there would be no chance of a misunderstanding. The distance from the bottom of the bottom retort in a bench of 6's to the crown of the arch inside is practically always the same, whether the bench be a ½-depth, ¾-depth or full-depth. Therefore, if the manufacturers would assume a distance from the top of the ash pan to the bottom retort for a ½-depth bench, and make this distance double for a full-depth bench, and half way between the two for a ¾-depth bench, there could be no possible misunderstanding of the terms.

"The depth of a bench, however, has always referred to a height of some kind, and in my opinion has nothing whatever to do with the preheating of the primary or secondary air, except that it must be understood that the recuperators occupy the full available space provided for them, and that there is not a foot or two of red brick or some other filling material put at the bottom of the recuperators where this space could be occupied by the recuperators proper.

"In regard to the preheating of the primary air in a bench, it has been my experience that it is not a good practice, as it has the same effect on a furnace that superheated steam has in a water gas machine; that is, to form clinkers. Preheating the primary air simply carries so much sensible heat into the furnace, where it should be the aim to keep the temperature of the fire down.

"There is not much difference in the ½-depth benches of different manufacturers, they all being about 12 feet 2 inches or 12 feet 3 inches from the ash pan pan to the crown of the arch inside; but, as you are well aware, when you get into ¾ and full-depth benches there are all sorts and kinds of dimensions. As long, however, as they have come to a pretty good understanding of what a ½-depth bench is, it seems to me that it would be a good plan to call a full-depth bench twice this depth, and a ¾-depth exactly half way between—that is, in respect to the height from the grate bars to the furnace arch, ashpan to the floor line, or ashpan to the bottom retort.

"There are some benches that have no furnace arch, the same as the Weber bench. It, therefore, might be advisable to assume a dimension from the ashpan to the bottom of the first retort, if the bench be a recuperative bench, no matter whether it is a bench of 4's, 6's, 8's or 9's."

From the above extracts from Mr. Polk's letter it will be seen he appears to favor absolute dimensions for benches of various depths. At first this plan appeared the most feasible to me, but after further study I believe I can suggest a better and more desirable rating, and this is largely the outcome of a suggestion by Mr. Fred Bredel. The real point at issue, as far as "depth" is concerned, is the actual working effective depth of the fire itself, at least it so appears to me. Then, why not work out a rating of benches on this basis?

As a general suggestion I may say that a fire 4 feet deep at the foot of the slope of fuel (for there usually is at least a slight slope) directly after firing will reduce to, say, about 3 feet just before the next firing. Three feet depth still allows the proper reactions to take place. As a fire for best working should be as nearly level as possible, I believe it would be more nearly correct to use the average effective depth of the fire just before firing up, and the maximum average effective depth that could be secured in the particular design under consideration.

As far as depth is concerned I offer the following suggestions as to rating recuperative benches. A *shallow producer* recuperative bench is to have an average effective fire depth just before firing of not less than 3 feet, and a maximum average effective fire depth of not over 5 feet. A *medium depth producer* recuperative bench is to have an average effective fire depth just before firing of not less than 5 feet, and a maximum average effective fire depth of not over 7 feet. A *deep producer* recuperative bench is to have an average effective fire depth just before firing of not less than 7 feet, and a maximum average effective fire depth of not over 10 feet. Anything deeper than 10 feet could be called special. By effective fire depth I mean the distance from the top of the grate bars to the top of the fuel, or the straight line distance from any opening between water pans, or elsewhere to the nearest upper surface of the fire, whichever is the least distance. I realize these are arbitrary divisions, but they have this in their favor—they cannot be misunderstood.

As far as grate area is concerned I will give the grate areas used by the manufacturer whose figures on recuperator surface and retort contents I have previously quoted:

So-called ½	depth bench	6's— 7.82	square feet.
" ¾	"	6's— 8.47	"
" full	depth "	6's— 8.82	"
" "	"	9's—13.90	"

This manufacturer figures the grate as the area of the throat of furenac. He takes a straight line from the brick wall in the front of the furnace just above the plates, to the nearest point of the brickwork in the back of the furnace. This he calls the length of the grate. For the width he takes the width at the grate bars and the width in the

1. Letter from Mr. F. Bredel to me, June 28, 1907.

upper part of the fire, and averages these dimensions and calls that average the width. This particular width multiplied by the particular length aforesaid gives the grate areas as stated above.

Grate area is simply a question of how much fuel can readily and in good practice be converted into producer gas per square foot of grate per hour. Owing to recent applications of return flue gases under the fires, it may be possible to burn much larger quantities of fuel per square foot of grate area per hour than formerly. I believe from 8 to 12 pounds of coke per square foot has been considered fair practice, but this bids fair to be increased very much. It appears to me to be wise to allow a reasonable amount of safety, and without considering the return flue gas scheme I would say that it would be safe to figure 8 pounds of Pittsburgh gas coal per square foot of grate per hour. At one time I had it in mind to figure 8 pounds pure carbon per square foot of grate per hour, but owing to the variation in composition of fuels, especially as regards ash contents, it does not seem right to put it on this basis. I would treat fuels as classes in such work, such as cokes, bituminous coals of certain grades, hard coals, etc., and secure a certain general figure for each class. With all the foregoing matters in mind then I would classify recuperative benches as follows – there would be three general classes:

First, shallow producer recuperative benches; second, medium depth producer recuperative benches; third, deep producer recuperative benches. For each of the three classes I would give the following definitions:

First, a *shallow producer* recuperative bench is one having an average effective fire depth just before firing of not less than 3 feet, and a maximum average effective fire depth of not over 5 feet. In such a bench the ratio of effective recuperation surface to effective interior surface of all retorts is to be not less than 40 per cent. Also in such a bench the ratio of effective recuperation surface in square inches to effective cubical contents of all retorts in cubic inches is to be not less than 9 per cent.; the grate area to be figured on the kind of fuel used.

Second, a *medium depth producer* recuperative bench is one having an average effective fire depth just before firing of not less than 5 feet, and a maximum average effective fire depth of not over 7 feet. In such a bench the ratio of effective recuperation surface to effective interior surface of all retorts is to be not less than 50 per cent. Also, in such a bench the ratio of effective recuperation surface in square inches to effective cubical contents of all retorts in cubic inches is to be not less than 10 per cent.; the grate area to be figured on the kind of fuel used.

Third, a *deep producer* recuperative bench is one having an average effective fire depth just before firing of not less than 7 feet, and a maximum average effective fire depth of not over 10 feet. In such a bench the ratio of the effective recuperation surface to effective interior surface of all retorts is to be not less than 60 per cent. Also, in such a bench the ratio of effective recuperation surface in square inches to effective cubical contents of all retorts is to be not less than 11 per cent.; the grate area to be figured on the kind of fuel used.

I wish to say right here that I realize as well as anyone that the figures in the foregoing definitions are arbitrary. Further, the grate area, for any given class of fuel, can probably be expressed as a relation to effective retort contents. Even if, as I expect, practice, further study and experimenting shall determine what figures are commercially the correct ones to be inserted in place of those I have given, yet I feel that these definitions point the way to a rational bench classification more satisfactory than any I have so far seen. At least we can reasonably hope that, in the course of time, still better and more simple definitions will result. I feel quite sure that we all agree that something better than the present ratings of benches is highly desirable, and we should all try to find out more about the subject. Very little really accurate and valuable knowledge and facts seem available at this date.

Certain Features of the Thermo-Chemical Principles of Gas Producer Operation.—Almost all of the writings on the subject of gas producers, as well as a great many patents, are filled with certain chemical reactions which have been used so much and so often that they have become stereotyped, so-to-speak. A great many people probably believe them just because they are stated over and over again by almost everybody.

This is the case with producer gas chemistry, and I wish to call attention to the facts, as stated by some of the most eminent scientists of the day, that we are not sure of these things as yet, and universal agreement concerning them is far from being reached. Therefore, all positive statements, and even the wording of such reactions in patents, are to be taken with several grains of caution. The ordinarily accepted thermo-chemical reactions in connection with the action of air in gas producers are to the effect that air, on coming into contact with carbon at the bottom of the fire, first unites to form carbon dioxide, and this carbon dioxide, on passing up through the incandescent fuel, is reduced to carbon monoxide by the addition of an atom of carbon, all as expressed in the following equations:

$$C + O_2 = CO_2, \text{ exothermic reaction.}$$
$$CO_2 + C = 2CO, \text{ endothermic reaction.}$$

Now if water vapor be present it is ordinarily believed that this water vapor dissociates, separating into hydrogen and oxygen (an endothermic reaction), the hydrogen passing on through the fire unchanged, while the oxygen first unites with carbon to form carbon dioxide, and this subsequently reduces to carbon monoxide, all as shown in the following equations:

$$H_2O = H_2 + O, \text{ endothermic reaction.}$$
$$C + O_2 = CO_2, \text{ exothermic reaction.}$$
$$CO_2 + C = 2CO, \text{ endothermic reaction.}$$

Now, let us see how these reactions and subjects are viewed by people who are probably careful in their investigations and whose opinion is worthy of serious consideration. I will first quote from "Die Gaserzeuger und Gasfeuerungen," by Ernst Schmatolla, Edition 1901. On page 4 of this book we have an explanation of the formation of carbon monoxide as follows:

"The incandescent carbon acts upon the carbon dioxide formed below, and which is rising upwards, in a reducing manner, in which carbon monoxide is formed by the addition of carbon to carbon dioxide as follows:

$$CO_2 + C = 2CO.$$

"Besides this, carbon monoxide is also formed through incomplete combustion as in this equation:

$$C + O = CO.$$

"This incomplete combustion can be explained, that in the upper layers of the fire there is only a very insufficient quantity of oxygen, not sufficient to produce carbon dioxide."

Note the statement that carbon monoxide is formed directly. Quoting the same author again, on page 11, we have the following: "Carbon monoxide gas is formed partly through incomplete combustion of carbon as per the equation:

$$C + O = CO.$$

"Also, partly owing to the action of incandescent carbon upon carbon dioxide as follows:

$$CO_2 + C = 2CO.$$

"The first process is one of oxidation, the latter of reduction; in the first process heat is developed (exothermic reaction), in the latter heat is absorbed (endothermic reaction)."

The same author treats the reactions caused by the introduction of water vapor under a fuel bed, pp. 11 and 12:

"As already stated in the first chapter, incandescent carbon dissociates water vapor. If the temperature of the fire is high, viz., greater than 1,000° C., hydrogen and carbon monoxide are formed by the action of incandescent carbon on water vapor after the formula:

$$H_2O + C = H_2 + CO.$$

If the temperature at which the reaction takes place is lower, especially if it drops below 800° C., the reaction between water vapor and carbon follows as per this equation:

$$2H_2O + C = 2H_2 + CO_2.$$

"As carbon dioxide is not a combustible gas, the producer should be operated so that the process indicated by the former equation takes place."

Schmatolla also gives the same reactions on p. 39, while explaining the production of so-called Dowson gas, and again, on p. 40, while presenting the reactions taking place in a water gas generator, in both cases laying particular stress upon the statement that the critical temperature is about 1,000° C.

I should consider as much more authoritative, as well as being more recent, the explanation of these thermo-chemical reactions as given by Prof. Hans v. Jüptner, in his "Lehrbuch der Chemischen Technologie der Energien," as given in the 1905 Edition, Vienna, Book I., Part 1. I wish to apologize for introducing such a lengthy quotation in a paper already much too long for an Association paper, but I feel that the value of this data by Prof. Jüptner is so great, and so little of it is known in this country apparently, that it would be a

shame to withhold it, especially as it will undoubtedly be of great assistance to us in the study of the thermo-chemistry of our business.

Quotation from Jüptner's Work—Incomplete Combustion.—"The complete combustion of the fuels used in ordinary thermo-chemistry operation results in carbon dioxide and water. If the chemical composition of the fuel is known, it is an easy matter to calculate the amount of oxygen theoretically required to obtain complete combustion. This amount is denoted as the theoretically necessary amount of oxygen for complete combustion. The average composition of dry air free from carbon dioxide is:

	By Volume.	By Weight.
Oxygen	21 per cent.	23 per cent.
Nitrogen	79 "	77 "
	100 "	100 "

And, therefore, it is an easy matter to compare the theoretical amount of air required to cause complete combustion. In reality, however, this theoretical amount of air is not sufficient, and it becomes necessary to use an extra amount of air, the quantity of which is expressed in a proportion of the theoretical amount of air required. The cause of this phenomenon is to be found partly in the mixing of the gases and the air for combustion, this being very difficult and in many cases very incomplete, and also partly due to the appearance of incomplete reactions. An incomplete combustion, therefore, can furnish different products, os the following example will show:

$$C + O \begin{cases} CO, \text{ or} \\ \frac{1}{2}(CO_2) + \frac{1}{2} C. \end{cases}$$

$$C_2H_4 + O_4 \begin{cases} 2CO_2 + 2H_2, \text{ or} \\ 2CO + 2H_2O. \end{cases}$$

$$C_2H_4 + O \text{ result in} \begin{cases} CO + CH_4, \text{ or} \\ CO + C + 2H_2, \text{ or} \\ C_2H_2 + H_2O. \end{cases}$$

"The number of various reactions that can appear simultaneously, and, therefore, influence each other, is frequently very large. It is entirely dependent on the conditions under which the reactions take place; the same is the case with the amount of the products formed by these reactions. These phenomena obey certain laws, as follows: In all these cases a 'chemical equilibrium' is spoken of, which is dependent on certain conditions, the so-called 'conditions of equilibrium.' Such conditions of equilibrium are: Temperature, pressure, electrical condition, the reciprocal propertion of the existing part of the element or 'the concentration.'

"When these conditions of equilibrium change, a change takes place in the condition of equilibrium itself in one sense or another, and, according to the following qualitative law, first formulated by Henry Le Chatelier, every change of any one factor of equilibrium (or stability) produces a change in the system in that direction in which that particular factor experiences a change in the opposite sense. This proposition becomes plainer when we resolve it into the following one:

"1. Each increase in temperature causes a change, which has the tendency to lower the temperature of the system (endothermic reaction) and the reverse (exothermic reaction). For example:

"a.) Dissociation.

$$CO_2 \rightleftharpoons CO + O - 68.2 \text{ Cal.}$$
$$H_2O \rightleftharpoons H_2 + O - 58.2 \text{ Cal.}$$

"In both these reactions heat is absorbed. Therefore, they are both caused and promoted also by increase in temperature. In opposition to this the reaction,

$$2\,CO \rightleftharpoons C + CO_2 + 42 \text{ Cal.}$$

in which heat is liberated, is promoted by a lowering of the temperature. Carbon monoxide will, therefore, be more stable at high temperatures. This reaction in the presence of platinum, iron, and especially nickel, takes place under approximate perfect diffusion, completely in the neighborhood of 300° C.

"b.) Incomplete Reactions:

$$CO_2 + H_2 \rightleftharpoons CO + H_2O - 10 \text{ Cal.}$$
$$CH_4 + CO \rightleftharpoons C_2H_2 + H_2O - 39 \text{ Cal.}$$

"In both reactions heat absorption takes place, therefore they are caused or promoted by increase in temperature. With lower temperature there will be present more $CO_2 + H_2$ or more $CH_4 + CO$; with higher temperature, however, more $CO + H_2O$ or more $C_2H_2 + H_2O$.

"The reverse conclusions are applicable for the example in the reactions

$$CO + H_2O \rightleftharpoons CO_2 + H_2 + 10 \text{ Cal.}$$

"Lower temperatures are more favorable to this reaction.

"2. Every increase of the external pressure causes a change in the equilibrium, which reduces the pressure, and *vice versa*. Example:

"a.) Dissociation.

$$2\,CO_2 \rightleftharpoons 2\,CO + O_2$$
$$2\,H_2O \rightleftharpoons 2\,H_2 + O_2.$$

"Through the dissociation of CO_2 or H_2O the volume (or with constant volume, the pressure) is increased by half. The dissociation, therefore, will increase with a decreasing pressure, but decrease with an increasing pressure.

"b.) Incomplete Reaction.

$$C_2H_2 + H_2 \rightleftharpoons CH_4 + C.$$

"The volume of the solid carbon is so small that it may be neglected; furthermore, C does not appear at all as a gas, but the volume (or with constant volume the pressure) of the CH_4 produced is only half as large as that of the original mixture of C_2H_2 and H_2. Increasing pressure is, therefore, conducive to the progress of the reaction. This appears plainly in an explosion in closed vessels, where the amount of CH_4 and C increases with the pressure. The equilibrium

$$CO + H_2O \rightleftarrows CO_2 + H_2$$

is independent of the pressure when H_2O appears as steam, because the volume on both sides is the same; and because the volumes are equal, the pressures are necessarily equal. The reaction

$$2\,CO = C + CO_2$$

is reduced by decreasing pressure, because the volume and also the pressure of CO_2 are only $\frac{1}{2}$ as great as that of 2 CO.

"3. Each increase in concentration of a body in any system causes a change in the condition of equilibrium, by which a certain amount of this body disappears, and *vice versa*.

The quantitative expression for the relation between the chemical equilibrium and the conditions of equilibrium (factors of equilibrium) varies, according to whether we refer to equilibrium at a certain temperature or generally to equilibrium at any temperature. In the first case—that is, for isothermic equilibrium—the law of mass is applicable; for the second common case the Van't Hoff equation (for volumetric concentration) or the Le Chatelier equation (for numerical concentration).

"In cases where gas mixtures are concerned, the last form is preferable for the reason that the numerical concentration follows directly from the composition of the gases in per cent. by volume.

"In the following we will consider an example that has especial interest for the thermo-chemical engineer. The dissociation of carbon dioxide:

"Carbon dioxide dissociates at high temperatures according to the equation

$$CO_2 \rightleftarrows CO + \tfrac{1}{2}(O_2).$$

"The general expression for Le Chatelier's formula is:

$$\frac{1}{R}\int \frac{Q_T dT}{T^2} + (N'' - N')\,l.\,P + \sum n_2\,l.\,C_2 - \sum n_1\,l.\,C_1 = \text{Constant.}$$

"In this formula

Q_T = amount of heat due to reaction at temperature T.

P = the pressure under which the system exists.

N'' and N' = the number of molecules existing on the right side and left side of the reaction.

"n_1 and n_2 also C_1 and C_2 = that number of molecules, or rather the concentration of the various bodies appearing in the reaction, where the indices 1 and 2 refer to the original system and final system.

"If, to simplify the computation, we use the common log., instead of the natural log., and putting $\frac{1}{R} = 500$, we can write our general expression:

$$500\int \frac{Q_T.dT}{T^2} + 2.3026\,(N'' - N')\log. P + 2.3026\,(\sum n_2 \log. C_2 - \sum n_1 \log. C_1) = \text{Constant.}$$

Now we have $N'' - N' = 1.5 - 1 = 0.5$, and

$$\sum n_2 \log. C_2 - \sum n_1 \log. C_1 = \log. \text{Constant} = \log. \frac{(\overline{C}_{CO})\ (\overline{C}_{O_2})^{\frac{1}{2}}}{\overline{C}_{CO_2}}$$

Making the total concentration of the system after equilibrium has taken place = 1, we have,

$$\overline{C}_{CO} + \overline{C}_{CO} + \overline{C}_{O_2} = 1.$$

"Assuming no superfluous oxygen exists we have from the reaction

$$\overline{C}_{O_2} = \frac{1}{2}\overline{C}_{CO} \qquad (2)$$

"Assuming x = the relation between the dissociated carbon dioxide (*i. e.*, the resulting carbon monoxide (and the amount of CO_2 which would be present if no dissociation had taken place, that, is $\overline{C}_{CO} + \overline{C}_{CO_2}$ = the coefficient of dissociation, then we have

$$x = \frac{\overline{C}_{CO}}{\overline{C}_{CO} + \overline{C}_{CO_2}} \qquad (3)$$

"From equations (1) and (2) it follows:

$$\overline{C}_{CO_2} + \frac{3}{2}\overline{C}_{CO} = 1;$$

$$\overline{C}_{CO_2} = 1 - \frac{3}{2}\overline{C}_{CO};$$

therefore,

$$x = \frac{\overline{C}_{CO}}{1 - \frac{3}{2}\overline{C}_{CO} + \overline{C}_{CO}} = \frac{C_{CO}}{1 - \frac{1}{2}\overline{C}_{CO}}$$

from this follows further:

$$x - \frac{x}{2}\overline{C}_{CO} = \overline{C}_{CO}$$

or,

$$\overline{C}_{CO} = \frac{x}{1 + \frac{x}{2}} = \frac{2x}{2 + x}$$

$$\overline{C}_{O_2} = \frac{x}{2 + x}$$

and:

$$\overline{C}_{CO_2} = 1 - \frac{3}{2}\frac{2x}{(2 + x)} = \frac{2(1 - x}{(2 + x)}$$

"By substituting these three values we have,

$$\text{log. Constant} = \text{log.} \frac{(\overline{C}_{CO})\ (C^{O_2})^{1/2}}{(C^{CO_2})}$$

$$= \frac{x^{3/2}}{(1 - x)\ (2 + x)^{1/2}} \qquad (30)$$

"For determining the constant the following observations made by Henry Saint-Claire-Deville will serve:

P = 1 atm.
T = 3,000 + 273 = 3,273.
X = 0.40.

"If we assume with Le Chatelier the amount of heat due to the reaction $CO + O \longrightarrow CO_2$ as independent of the temperature, which is strictly speaking not correct, but nevertheless permissible for first approximation, and take Q = 68.2 Cal., we have—

$$500 \int \frac{68.2 dT}{T^2} + 1.1513 \text{ log. P.} + 2.3026 \text{ log.}$$

$$\frac{x\ 2/3}{(1 - x)\ (2 + x)^{1/2}} = \text{Constant.}$$

or, because for P = 1 atm.; log P = o.

$$\text{Constant} = -\frac{500 \times 68.2}{3,273} + 2.3026 \text{ log.} \frac{(0.4)\ 3/2}{0.6\ (2.4)^{1/2}} = -11.7192$$

"Therefore,

$$-\frac{34,100}{T} + 1.1513 \text{ log. P} - 2.3026 \text{ log. Constant} = -11.7194,$$

or,

$$\text{log. Constant} = \left(\frac{34,100}{T} - 11.7192 - 1.1513 \text{ log. P.}\right)\frac{1}{2.3026}$$

$$= \frac{14,809}{T} - 5.0895 - 0.5 \text{ log. P.}$$

"From this Le Chatelier has calculated the following values of x:

Temp. Deg. C.	Pressure in Atmospheres. 0.001	0.10	0.1	1	10	100
1,000	0.007	0.003	0.0013	0.0006	0.0003	0.00015
1,500	0.07	0.035	0.017	0.008	0.004	0.002
2,000	0.40	0.125	0.08	0.04	0.03	0.025
2,500	0.81	0.60	0.40	0.19	0.09	0.04
3,000	0.94	0.80	0.60	0.40	0.21	0.10
3,500	0.96	0.85	0.70	0.53	0.32	0.15
4,000	0.97	0.90	0.80	0.63	0.45	0.25

"The results of these computations coincide with the observations which have been made at about 1,500° C. on the density of carbon dioxide."

Producer or Air Gas.—"If a limited amount of air is permitted to pass through a layer or bed of pure carbon (in practice charcoal or coke), incomplete combustion takes place—that is, carbon monoxide is formed from the influence of the oxygen on the incandescent carbon:

$$C + \frac{1}{2}(O_2) = CO.$$

"Beginning with the nearly correct assumption that air contains 1 molecule of oxygen to 4 molecules of nitrogen, we can write our reaction as follows:

$$C + \tfrac{1}{2}(O_2) + 2N_2 = CO + 2N_2.$$

"We, therefore, produce, according to the above reaction, a gas that theoretically contains, to 1 molecule of CO 2 molecules of N_2, and its composition would have to be

CO ..... 83.3 per cent. by volume.
N ..... 66.7 " "

Upon combustion this gas should furnish for each 22.42 liters under constant volume 0.333 × 67.9 = 22.61 Cal. Under constant pressure 22.61 + 0.5 × 0.54 = 22.88 Cal. Therefore, its heating value (constant pressure) would be per 1 cbm.,

$$\frac{22.88 \times 1,000}{22.42} = 1,020.5 \text{ calories.}$$

The heating value of 1 gramme of gas results as follows: According to the reaction the gas contains per 1 gramme-atom of carbon,

12 grm. carbon, 16 grm. oxygen } 28 grm. carbon monoxide.
4 × 14 = 56 grm. nitrogen.

Total.... = 84 grm.

"As 84 grm. of the gas contain 3 molecules (CO + 2 N_2) 22.42 liter of the gas (at 0° C. and 760 mm. barometer) contain $\frac{84}{3}$ = 28 grm. and 1 grm. of the gas therefore develops $\frac{22.88}{28}$ = 0.817 Cal.

"The previous reaction only takes place at very high reaction temperatures. With low reaction temperatures a second reaction appears and takes place simultaneously with the other, and in the more apparent manner, the lower the reaction temperature drops, namely the reaction

$$C + O_2 = CO_2$$

or if we permit air to act instead of oxygen

$$C + O_2 + 4\ N_2 = CO_2 + 4\ N_2.$$

"For every temperature (and every pressure) there exists between these two reactions a certain definite relation of equilibrium, which we will now study.

"If we subtract the equations

$$C + O_2 = CO_2$$

and

$$2\ C + O_2 = 2\ CO$$

from each other we obtain the equation

$$2\ CO = CO_2 + C$$

which represents a reaction that actually takes place at not too high temperatures and defines the relation at which the first two reactions appear simultaneously. The reaction

$$2\ CO \rightleftarrows CO_2 + C$$

is reversible; that is, while pure carbon monoxide gas within certain limits of temperature dissociates into carbon dioxide and carbon, pure carbon dioxide under the same conditions dissociates solid carbon to carbon monoxide, thus simultaneously being reduced to carbon monoxide. Therefore an equilibrium is established between carbon monoxide and carbon dioxide and carbon that is dependent on the temperature and the concentration, *i. e.*, the gas pressure.

"As two volumes of the CO form only one volume of CO_2, the reaction taking place in the sense of our equation reading from left to right under a decrease in volume, an increase of pressure would promote the formation of CO_2, whereas a decrease in pressure would promote the formation of CO. If in the producer we, therefore, desire to generate a gas very rich in CO, we should not admit the blast (primary air) under too high a pressure.

"To ascertain the influence of the temperature on the equilibrium, we must know the amount of heat due to the reaction. This we accomplish (for 18° C) in the following manner:

$$C + O_2 = CO_2 \qquad 94,310 \text{ Cal.}$$
$$2\ (C + O) = 2\ CO_2 \times 26,700 = 53,400 \text{ "}$$
$$2\ CO = CO_2 + C \qquad 40,910 \text{ "}$$

That is, the decomposition of carbon monoxide into CO_2 and C takes place with a development of heat (exothermic). Therefore. an increase in temperature will promote the production of carbon monoxide, whereas a decrease in temperature, however, is not advantage-

ous to its formation. From this we can see offhand that we get a better gas—that is, a gas richer in CO—the higher the temperature of the producer.

"All these considerations refer to the condition of equilibrium. Whether this condition is actually reached in practical operation or not, is dependent on several conditions (such as depth of material, porosity of same, blast velocity, etc.). In any case it is not only important from a standpoint of producer theory, but also from a practical operating condition, to know the various relations of this equilibrium, as it is only possible to get a good basis for comparison by being able to secure the results obtained from practical operation under corresponding theoretical conditions of equilibrium.

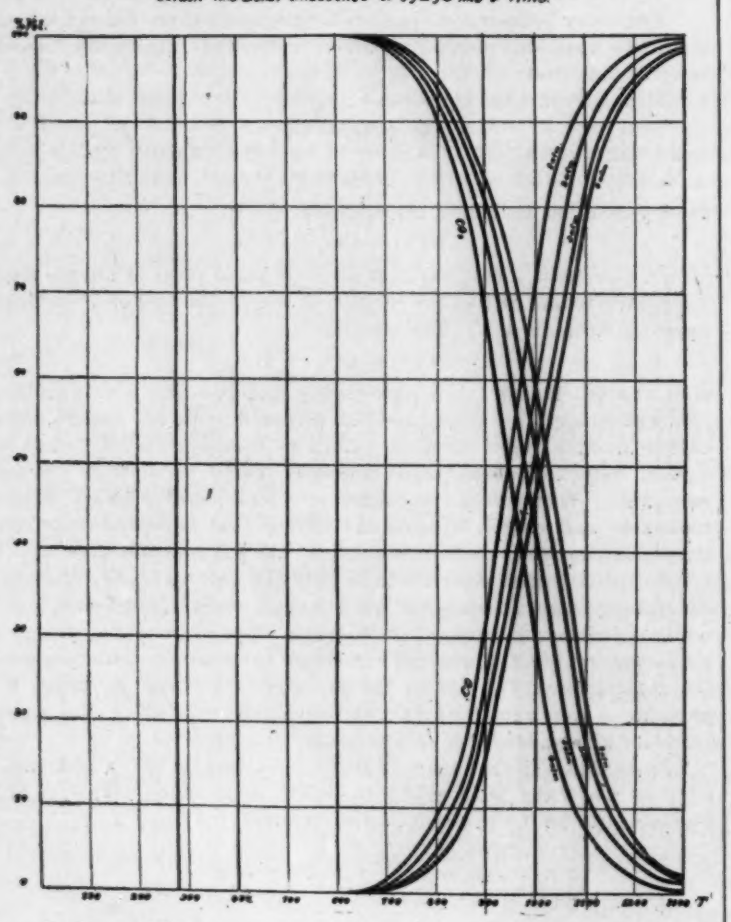
"It would carry us too far to go further into the details of securing such results, as this has been discussed thoroughly at other places (Jüptner, 'Lectures on the Theory of Generator and Water Gas;' Ahrens, 'Collection of Chemical-Technical Lectures'). In this manner we obtain the following information regarding the ideal composition of producer gas at various temperature and pressure.

"A. Ideal composition of producer gas, generated with pure oxygen.

Blast Press.	1 atmo.		2 atmo.		3 atmo.		4 atmo.	
Composition in Per Cent. by Vol. at Temperature of	CO	CO_2	CO	CO_2	CO	CO	CO	CO_2
227° C. 500° abs.	0.004	99.936	0.0028	99.9972	0.0023	99.9977	0.002	99.998
327 " 600 "	0.123	99.877	0.087	99.913	0.0711	99.9289	0.061	99.939
427 " 700 "	1.427	98.573	1.011	98.989	0.826	99.174	0.716	99.284
527 " 800 "	8 794	91.206	6.303	93.697	5.177	94.823	4.499	95.591
627 " 900 "	32.542	67.458	24.809	79.191	20.408	79.592	17.945	82.055
727 " 1,000 "	70.35	29.65	58.705	42.295	51.788	48.212	47.017	52.983
827 " 1,100 "	92.75	7.25	87.198	12.802	82.72	17.28	78.987	21.013
927 " 1,200 "	98.445	1.555	97.00	3.00	95.65	4 35	94.315	5.685
1,027 " 1,300 "	90.50	0.50	99.00	1.00	98.97	I.03	98.67	1.33

"Fig. 82 shows the contents of this table in diagrammatic form.

Curves showing Ideal Composition of Producer Gas generated with pure Oxygen and Blast Pressures of 1, 2, 3 and 4 Atms.



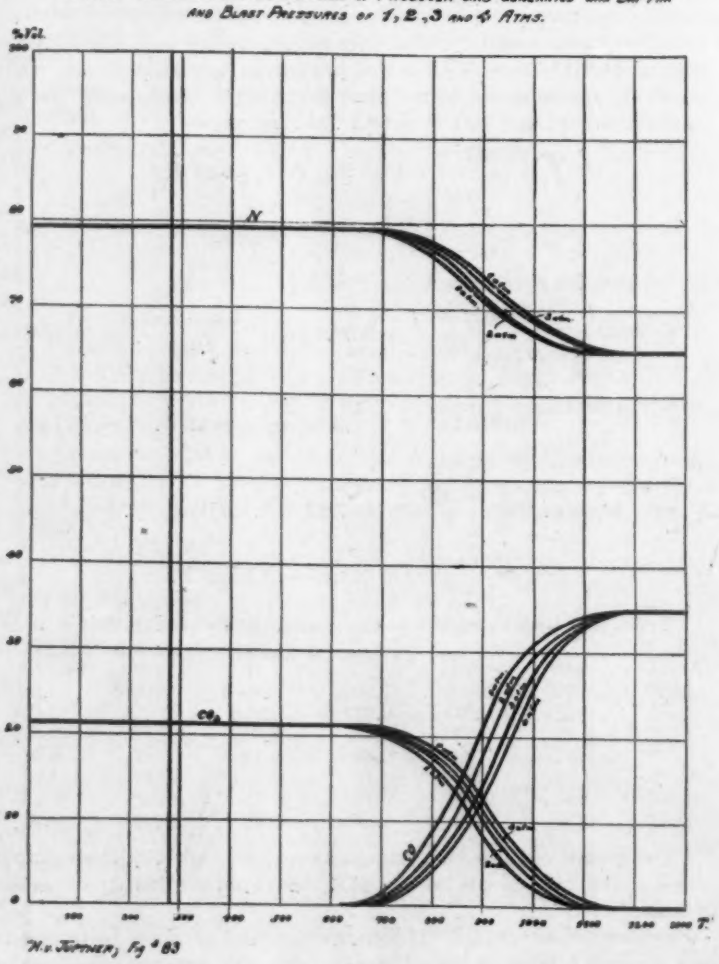
N. v. Jüptner. Fig. 82.

"B. Ideal composition of producer gas generated with dry atmospheric air.

Temperature of Gasification		Partial Pressure of CO + CO_2 in Atmosphere.	Composition in Per Cent. by Vol.		
t° C.	T° Abs.		CO_2.	CO.	N_2.
Blast Pressure equals 1 Atmosphere.					
227	500	0.21	21.00	....	79.00
327	600	0.21	21.00	....	79.00
427	700	0.2145	20.31	1.14	78.55
527	800	0.24	16.40	7.60	76.00
627	900	0 29	8.75	20.25	71.00
727	1,000	0.334	2.14	31.26	66.60
827	1,100	0.344	0.47	33.93	65.60
927	1,200	0.346	0.14	34.46	65.40
1,027	1,300	0.3465	0.01	34.65	65.35
Blast Pressure equals 2 Atmospheres.					
227	500	0.42	21.00	....	79.00
327	600	0.42	21.00	....	79.00
427	700	0.428	20.39	1.01	78.60
527	800	0.446	17.48	5.82	76.70
627	900	0.555	10.66	17.09	72.25
727	1,000	0.6535	3.12	29.56	67.32
827	1,100	0.6865	0.59	33.74	65.67
927	1,200	0.692	0.16	34.44	65.40
1,027	1,300	0.693	0.09	34.56	65.35
Blast Pressure equals 3 Atmospheres.					
227	500	0.63	21.00	....	79.00
327	600	0.63	21.00	....	79.00
427	700	0.6395	20.51	0.81	78.68
527	800	0.686	18.14	4.76	77.10
627	900	0.8075	11.94	14.98	73.08
727	1,000	0.957	4.31	27.59	68.10
827	1,100	1.025	0.83	33.37	65.80
927	1,200	1.0365	0.21	34.34	65.45
1,027	1,300	1.04	0.10	34.56	65.34
Blast Pressure equals 4 Atmospheres.					
227	500	0.84	21.00	....	79.00
327	600	0.84	21.00	....	79.00
427	700	0.851	20.59	0.71	78.70
527	800	0.905	18.52	4.11	77.37
627	900	1.056	12.73	13.67	73.60
727	1,000	1.258	5.00	26.46	68.55
827	1,100	1.359	1.13	32.85	66.02
927	1,200	1.381	0.28	34.25	65.47
1,027	1,300	1.385	0.13	34.50	65.37

"The data contained in the above table are still plainer in the graphical representation in Fig. 83.

Curves showing Ideal Composition of Producer Gas generated with Dry Air and Blast Pressures of 1, 2, 3 and 4 Atms.

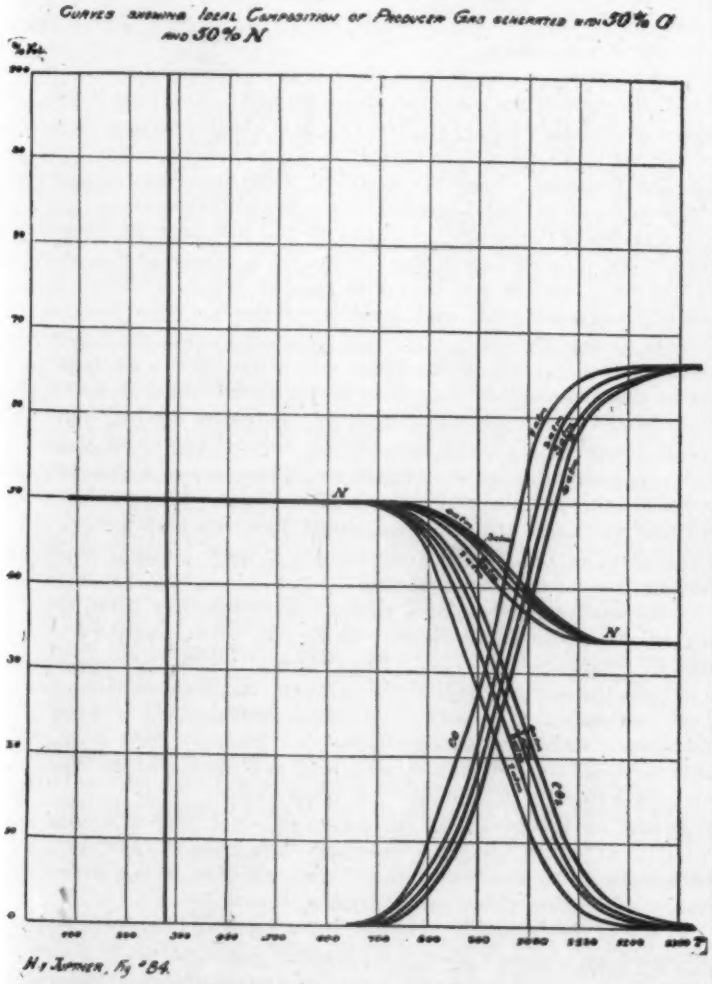


N. v. Jüptner, Fig. 83

"As in all probability in the future a gas containing 50 per cent. of oxygen and 50 per cent. nitrogen will have to be considered in the

operation of producers, we will give the ideal composition of the gas for such a case.

Temperature of Gasification t° C.	Temperature of Gasification T° abs.	Partial Pressure of CO + CO_2 in Atmosphere.	Composition in Per Cent. by vol. CO_2.	CO.	N_2.
Blast Pressure equals 1 Atmosphere.					
227	500	0.50	50.00	....	50.00
327	600	0.50	50.00	....	50.00
427	700	0.502	49.40	0.80	49.80
527	800	0.522	43.40	8.80	47.80
627	900	0.568	29.60	27.20	43.20
727	1,000	0.633	10.10	53.20	36.70
827	1,100	0.66	2.00	64.00	34.00
927	1,200	0.663	1.10	65.20	33.70
1,027	1,300	0.6655	0.35	66.20	33.45
Blast Pressure equals 2 Atmospheres.					
227	500	1.	50.00	....	50.00
327	600	1.	50.00	....	50.00
427	700	1.0035	49.56	0.61	49.83
527	800	1.0295	45.65	5.83	48.52
627	900	1.1065	34.03	21.30	44.67
727	1,000	1.23	15.50	46.00	38.50
827	1,100	1.308	3.80	61.60	34.60
927	1,200	1.326	1.10	65.20	33.70
1,027	1,300	1.3305	0.43	66.10	33.47
Blast Pressure equals 3 Atmospheres.					
227	500	1.5	50.00	....	50.00
327	600	1.5	50.00	....	50.00
427	700	1.5045	49.55	0.60	49.85
527	800	1.538	46.20	5.07	48.73
627	900	1.6345	36.55	17.93	45.52
727	1,000	1.814	18.60	41.87	39.53
827	1,100	1.9455	5.45	59.40	35.15
927	1,200	1.986	1.40	64.80	33.80
1,027	1,300	1.9955	0.45	66.07	33.48
Blast Pressure equals 4 Atmospheres.					
227	500	2.	50.00	....	50.00
327	600	2.	50.00	....	50,00
427	700	2.0053	49.60	0.54	49.86
527	800	2.0443	46.68	4.43	48.89
627	900	2.1615	37.89	16.15	45.96
727	1,000	2.384	21.20	38.40	40.40
827	1,100	2.588	5.90	58.80	35.30
927	1,200	2.6435	1.74	64.35	33.91
1,027	1,300	2.6605	0.46	65.05	33.49



"Fig. 84 gives the corresponding diagram for these tables. From this we can draw the following conclusions:

"1. In every case the amount of carbon dioxide contained in the ideal producer gas at low temperatures has a maximum that remains practically constant at about 400° C.

"2. With rising temperatures the amount of carbon dioxide decreases and becomes, depending on the circumstances, nearly zero between 800° C. and 1,000° C.

"3. The amount of carbon monoxide is nearly zero up to about 400° C.

"4. With rising temperatures the amount of carbon monoxide increases and reaches a maximum, depending on circumstances, between 800 and 1,000° C.

"5. The amount of carbon dioxide increases at a steady temperature according to the pressure and, therefore, also according to the amount of oxygen contained in the primary air.

"6. The amount of carbon monoxide produced is in the opposite manner from (5).

"7. At low temperatures the absolute amount of carbon dioxide increases with the amount of oxygen contained in the primary air, and,

"8. At high temperatures the absolute amount of carbon monoxide contained in the gas increases with the amount of oxygen contained in the primary air.

[To be Continued.]

The Thermometer in the Gas Works.[1]

[Communicated by "R."

While the common thermometer is a very useful instrument in all lines of manufacturing for testing temperatures, it is of special importance in the gas industries. Nevertheless, the ins-and-outs of the everyday thermometer are not fully comprehended by many, a conclusion I came to after visiting certain gas works. While we do not need lessons in calorics in order to utilize the thermometer to best advantage, we should be somewhat familiar with the project. We can, for illustration, take three pails of water and arrange them side by side; in one pail the water should be hot, in the second it should be cold water, and in the other its temperature should be about midway. Then, put one hand in the cold and the other hand in the hot water, permitting both hands to be submerged, as in Fig. 1, for a short time. Then withdraw both hands and place them in the lukewarm, or medium warm water. The hand that was in the cold water will feel warm and the hand that was in the warm water will feel cool; and there you have it. Which hand can you believe? And so it goes with the thumbrule of our forefathers. They used to guess at distances and temperatures. They would pace off a certain measurement with the feet, and they did not have much use for improved contrivances for measuring temperatures or lengths. They got everything wrong, so mistakes and losses were many.

Conditions have changed. The rule-o'-thumb is passing away, for we have to be accurate now. Everything is made quicker and cheaper, if not better. Blundering guesswork has no place in the gas works of to-day, hence the need of the improved devices in all lines of work. The thermometer comes under the head of improved conditions—that is, the modern pattern of thermometer; and the modern pattern of gas works' thermometer is a worthy instrument. Its operation depends upon the well known expansion and contraction of a matter; that is, well known to most men engaged in the gas business. I met with a number of workmen in gas plants who had no idea of the internal construction of the thermometer which they were using every day, nor of the principle of operation of the same. Hence, attention is called to the two examples shown in Figs. 2 and 3. In the latter is shown a ball, *A*, in the act of being passed through a ring; both ball and ring are of metal. There is a margin of space between the edge of the ball and the ring and the ball is passed back and forth through the opening very easily. But the parts are next heated. The action of the heat units on the metal causes expansion and you cannot get the ball through the ring, for it will be choked off, as at *B*, Fig. 3.

If the parts cool down the ball drops through the ring with space to spare. Hence the principle of contraction and expansion resulting from exposure to heat or cold. The same principle applies to the working order of the thermometer. The mercury or other liquid is confined in the glass bulb and, when subjected to heat or to cold, rises or falls accordingly. It is all simple enough, yet I met with experienced men who seemed to fail to understand the minute details of the thermometer and, therefore, abused the instrument to the extent of causing it to do unsatisfactory work. For example, in one gas works where some testing of temperatures was in progress, the individual making them grasped the glass tube of the thermometer in his hand, as shown in Fig. 4. Of course, the warmth developed by contact with his hand threw the reading of the thermometer com-

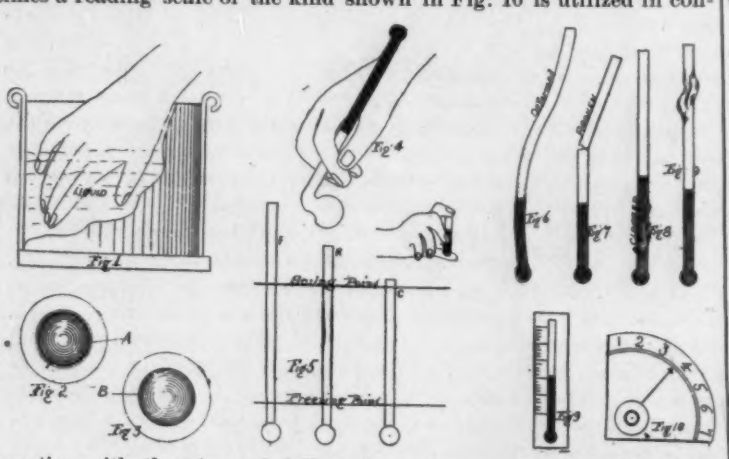
1. For the beginner.

pletely out. Then, again, I saw another person handle the little glass testing tube, as in Fig. 4, at the lower right corner, where a sample grip of a certain man's hand is shown. Thermometers cannot be operated this way. You cannot hang the instrument out in the sun and get the right readings of the atmospheric condition. You cannot hang the thermometer on a wall and expect to get a definite registering of the temperature of the room, because it may be cold or hot on the other side of the wall and the heat or the cold transmits through enough to disturb any thermometer. I observed many cases of hanging thermometers on parting walls. Hang your glass out from the wall on a hook. Or, better still, hang it in the middle of the apartment.

The bore in the tube is made by the employment of a hair when the tube is drawn. The bulb is blown on the end and the interior is filled with mercury. The heating of the mercury causes it to rise and fall according to the degrees of heat prevailing. In Fig. 5 the different types of thermometers in general service and their relation to each other are shown. Fahrenheit was the inventor, as we all know, and hence the first letter of his name has been adopted for purposes of making a reading point on the scale. Fahrenheit got his scale from the degrees of heat required to melt ice and the degrees of cold required to freeze water into a hard form. You can find Centigrade scale thermometers in use in gas works as well. In fact, several different kinds may be located, but all operate upon practically the same principles.

Some of the thermometers are woefully abused. I found some in a bent form, due to the use of defective tubing, as in Fig. 6. Fig. 7 illustrates a broken tube, which of course puts the upper part of the thermometer out of action. Yet this tube was in use in a division of a gas works. I likewise saw a tube wound with cords, as in Fig. 8, and another in which the tube was split near the top, as in Fig. 9. While tubes of this kind may be made to do, they will not perform accurate service. In order to get true readings, perfect tubes and proper adjustments are required.

Fig. 9 is a good form of thermometer for general service in gas works. It has a metal back and which back protects the tube. Sometimes a reading scale of the kind shown in Fig. 10 is utilized in connection with the rise and fall of the mercury. The principle is the same as that employed for having a reading clock in the office for showing how the steam pressure is in the engine room.



Address of the President (Mr. William J. Clark) of the National Commercial Gas Association, on the Occasion of Its Second Annual Meeting.

In article one, section one, of our by-laws, the following paragraph occurs: "At each annual meeting the President shall present an address setting forth his official acts and such general items and recommendations as he may deem of advantage to the Association."

I think it is well at this time to call to your attention and reiterate the objects for which this Association was formed. This will enable us, in reviewing the work of the last year, to measure up as an Association and as individuals, to what degree we have promoted the objects of our Association.

Article II.—Objects.—1. The object of this Association shall be, First: The promotion of increased sale of gas, and the promulgation of ways, means and methods necessary thereto. Second: The encouragement of manufacturers to produce high grade and highly efficient devices that require gas for light, heat and power.

2. The establishment and maintenance of a spirit of fraternity between the members of this Association, by friendly exchange of information and ideas on the before-mentioned subject matters, and by social intercourse.

3. The inducement and extension of more cordial and friendly relations between consumers and producers of gas, based upon mutuality of interest.

4. A substantial recognition of the value of the gas appliance manufacturer to gas interests, and his importance to the commercial end of the gas industry, as well as the encouragement of fraternal intercourse between the sales division of the gas industry and the appliance manufacturers, also between the commercial interests of the gas companies and merchants who make one of their special features the sale of devices for producing light, heat and power wherein gas is the element required.

The unqualified success of our meeting of last year is a matter of history. It stamped the exhibition feature of our convention as one of the vital and most effective factors in the promotion of the commercial end of the industry, and quoting the report of the committee on the President's Address last year we read: "We also approve of the recommendation of the feature of having an annual exhibition, for, at such a convention of commercial gas men especially, no better method for educational purposes could be more appropriate and fitting, and this committee earnestly recommend that this feature of our annual meetings be recognized as a necessary adjunct and the means of attaining and accomplishing the full purpose of the Association's desire in promoting the commercial industry of the gas business."

Now, after having set forth the avowed purpose of the Association and the expression of this committee in relation to the exhibition, I think it is well to make a few explanatory remarks as to why the Association is holding no official exhibition at this time, and the reasons leading up to this decision by your Board of Directors and Ways and Means Committee, which decision was arrived at at a joint meeting held in the early part of December.

Your board of officers early in the year realized that we were approaching a period of financial stress and that there was an indication of an approach of abnormal conditions. As this became more marked it was deemed advisable to request our secretary to canvass the situation through correspondence with our members who were exhibitors at last year's convention.

The plans formulated up to this time had in view a very much more extensive and elaborate exhibition than that of last year which would incidentally incur a very much larger outlay of money and obligation of the Association.

This canvass having been made and the correspondence gotten in hand, the committees convened and thoroughly analyzed the written expressions of the members. The tone of the letters evidenced no lack of interest in the project, but the tone of many of the letters indicated that the financial stringency would be a bar to enthusiasm which is the most essential factor making for a successful exhibition.

A number of the writers said that they would send their goods and men to the place of convention and would do their best to make the exhibition a success, but would be pleased if the exhibition feature might be deferred until such time as we reached more normal conditions in the financial situation. The committee thereupon concluded to hold no official exhibition at this time and took up the matter of the convention. The time and place of meeting not having been named at our last convention, the committee decided upon New York city as the place and January 8th, 9th and 10th as the dates.

We had already named the subjects of our papers and practically arranged our program. I think a glance at the list of subjects and writers will show that the commercial field has been well covered, the writers having been selected because of their peculiar fitness and ability to handle their respective subjects.

We are to be congratulated that we have upon our list of speakers a gentleman who stands foremost in the gas industry of the world today—a gentleman who stands for progress in every department and I am pleased at this time, in the name of the National Commercial Gas Association to pay this tribute to the scholarly and esteemed gentleman who occupies the eminent positions of President of the Stevens Institute of Technology, as well as President of the American Gas Institute—Dr. Alexander C. Humphreys.

Taking up the paragraph in regard to the President's address in which it says that "he shall make recommendations as he may deem of advantage to the Association," I should like to lay stress upon one or two points which should be accentuated.

In one of the technical journals of the lighting field there recently appeared an editorial upon the future of gas lighting, in which the suggestion was made that gas lighting is being driven to the wall by the electric light. If this be so (which, of course, the gas man is not willing to admit), then it behooves the gas man to be up and doing.

I believe it to be a fact that the gas man has given his best energies during the last few years to developing the gas fuel output, and has consequently, to a certain extent, neglected the lighting field. He has, so to speak, rested on his oars after the tremendous stride which was taken in the gas lighting field through the advent of the incandescent mantle.

I think this is made apparent by his lack of interest in that most important branch of his art—illuminating engineering.

The discussions of lighting problems in the Illuminating Engineering Society show a woeful lack of papers and discussions by gas men. A glance over the transactions show that the time is almost wholly given over to the electric lighting problems, and for this, I think the gas man is wholly to blame. I have attended many of the meetings and find only a handful of gas men in attendance and few of them taking part in any of the discussions. This is not because they are not welcome, but by reason of the fact that it is almost impossible to get the gas men to take a lively interest in the proceedings, and I think this is one of the sources of the editor's impression, who wrote the article referred to, and who says further on: "It would be interesting and highly instructive to see what could be done for rehabilitating gas as a first-class illuminant by the application of the same quality of energy, progressiveness, originality and perseverance in presenting its possibilities to the public being displayed by the majority of central stations."

I think it is generally conceded that the gas companies have made very little effort toward educating the public in regard to modern methods and possibilities of gas lighting, and what I wish to lay particular stress upon is the necessity of the gas companies entering into a systematic educational campaign along these lines.

In almost every home, shop and office we see evidences of a woeful waste of our product, through glaring faults of light distribution. It has been stated by those qualified to express the opinion that fully 50 per cent. of the light produced at the burner is wasted.

Let us look for a moment at what this means to the gas consumers in the matter of dollars and cents. Quoting 1905 figures, the amount of our product which is sold annually in the United States, approximates 112 billion cubic feet—worth, say, in round numbers, 112 million dollars. Let us allow, say, 40 per cent. of this amount for purposes other than illumination and we have, say, 67 billion feet for illuminating purposes.

Now, if the experts who made the estimate as to the loss or waste of 50 per cent. of this vast amount through unintelligent and wasteful methods is approximating a correct statement, then there are some 33 million dollars' worth of gas wasted annually in the United States.

The possibility of the saving of even a small proportion of this to the consumer, or better still, by diverting it to a useful channel and applying it to even out the load, makes it a wonderful field for operation. I put this forth as one of our most vital problems for your solution.

One more thought which I would like you to carry away with you and which also means an educational campaign, is the establishment and promotion of *goodwill*. We hear much discussion in relation to the intangible assets of a Public Utilities Corporation and looming up prominently is this most valuable asset - *goodwill*, without which the corporation is badly handicapped. No matter how much energy and money are expended by the management, unless the feeling of cooperation and heart interest in the work is cultivated in the employees, much of the energy and money goes to waste. I am a firm believer in the efficiency of the educating of the employee. The prejudice for or against the company by the public lies almost wholly in the hands of the employees, and if they are discourteous or careless in their methods it reflects directly upon the management and the public takes it for granted that if discourteous methods prevail it is because they are sanctioned by the officers, or those in authority.

It would pay us to spend a lot of time and money in educating the employees up to a realization of the importance of tactful and businesslike methods. There are many ways by which this may be accomplished, the best of which I believe to be, the organizing of Progress Clubs which shall have frequent meetings at which interesting conferences may be had—lantern slide exhibitions given—and object lessons showing workmanlike methods of handling appliances.

At these meetings all the departments should be represented. These matters are such as I should think should come directly into the province of the members of the National Commercial Gas Association, and the best methods for their promotion should be worked out by our members.

As to the future of this Association, it is safely assured. What we have accomplished in the past is an indication of what we have only begun to do. We are growing in numbers and importance in the industry each day and with the return to normal financial conditions which the near future promises, and with which will come the hearty co-operation and enthusiasm of all, we are bound to eclipse all our past achievements.

The Effect of Coal Gas on the Corrosion of Wrought Iron Pipe Buried in the Earth.

Mr. William Dudley, of the Vanderbilt University, Nashville, Tenn., recently conducted an investigation on this subject, the task having been undertaken in connection with a study of the conditions causing the corrosion of pipe laid under the streets in the city of Nashville. The investigator compiled the results of his researches in the shape of a paper which was read by him at the last session of the New York Section of the American Chemical Society. The paper was subsequently reprinted in the *Journal* of the Society, and it is to that source we are indebted for our knowledge of Mr. Dudley's determinations. The author wrote:

Five samples of earth were collected as representative of the various types in which the pipes are laid.

Sample No. 1 was taken from a street at the depth of the gas pipes. It was an old fill. Sample No. 2 was taken from about 4 feet from the surface on private property in the heart of the city, 50 feet from the sidewalk, and was a yellow clay. Sample No. 3 was taken from between the car tracks just under the street metal. It was a loamy clay. Sample No. 4 was a clay taken from a vacant lot in the northern part of the city. Sample No. 5 was taken from under the car tracks in the southern part of the city, and was a mixture of clay and loam.

The analyses of the samples gave the following results in percentages:

Sample.	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
Moisture (sample air dried)..	15.37	15.82	14.41	13.95	14.98
Chlorine	0.04204	0.01501	0.0018	0.0006	0.0024
Nitrogen, as nitrates	0.01501	0.22523	0.006	0.003	0.0015
" as nitrites.	0.00008	0.000002	trace	none	trace
" as ammonia	0.000306	0.000165	0.000011	0.000039	0.000042
Albuminoid ammonia	0.00128	0.000052	0.00002	0.000021	0.000021
Alkali equivalent (Na_2CO_3)...	0.0382	0.0478	0.0324	0.0057	0.0318
Sulphuric anhydride (SO_3) ...	0.0134	0.019	0.448	0.0073	0.0424
Humus	2.04	3.40	2.05	1.4	2.7

Wrought iron pipes, 1 inch inside diameter and 10½ inches long, were carefully cleaned and freed from all oxide by immersing in a warm ammoniacal solution of ammonium citrate for 20 minutes (or longer if necessary), brushing with a stiff brush, rinsing with distilled water, and drying rapidly.

The ammonium citrate solution is made by dissolving 40 grams of citric acid in water and neutralizing with the requisite amount of ammonium hydroxide of sp. gr. 0.896, required by the equation:

$$C_6H_8O.H_2O + 3NH_4OH = \text{Etc.}$$

The solution is then diluted to 460 cc. and contains approximately 10 per cent. of ammonium citrate. The citrate solution acts more rapidly on the iron oxide when warmed and has very little effect on metallic iron. A clean and bright piece of iron, having a surface of about 15 square inches, was allowed to remain in the solution for 24 hours, and no effect on the surface was observed nor was any appreciable loss of weight noted.

The pipes were weighed and plugged at one end with corks driven in about ¼ of an inch beyond the edge, and this space was filled with melted paraffine to keep the moisture in the earth from getting inside.

The samples of earth were each put in a wooden box of 1 cubic foot capacity, painted inside with asphalt paint to prevent the soluble constituents of the wood from permeating the earth. The pipes were placed in an upright position in the boxes (with the closed ends down) and the samples of earth were carefully tamped around them to within 1 inch of the top.

The earth in each box was to have been sprinkled daily with 50 cc. of water, so as to maintain natural underground conditions as far as possible, but the person in charge of this series of experiments neglected this precaution during a large part of the time. However, as each received the same treatment, the results are comparable, although they are all too low, except in the case of sample No. 5, which will be referred to later.

At the end of 12 months the pipes were removed, cleaned with the citrate solution, as previously described, and weighed.

The results are as follows:

Sample of Earth.	Original Weight of Pipe. Grams.	Final Weight of Pipe. Grams.	Loss of Weight Grams.
No. 1	624.49	603.93	20.56
" 2	652.45	638.92	13.53
" 3	665.76	663.20	2.56
" 4	680.81	678.30	2.51
" 5	618.90	606.50	12.40

The results, except that for sample No. 5, show that the amount of corrosion is determined practically by the chlorine content in the earth. There is some error in the result obtained from sample No. 5, which I am not able to discover, but that the result is entirely abnormal will be shown clearly later on.

The series of experiments designed to show the effects of coal gas on the corrosion of the pipe were conducted under the specified conditions in every detail. Into each box was placed an L, made of ¼-inch gas pipe, one limb passing vertically down one corner of the box and the other along the bottom to the diagonal corner. The limb along the bottom was perforated on the under side with numerous ¼-inch holes uniformly distributed and the end was plugged. The gas was admitted to this pipe through a standard meter reading to one-hundreth of a cubic foot.

One-half of a cubic foot of coal gas was admitted into each box daily, except Sundays, and at the same time the earth was moistened by sprinkling with 50 cc. of water. The boxes were covered with canvas so as to prevent the moisture from evaporating too rapidly.

In the samples of earth, Nos. 2, 3, 4 and 5, two pipes were placed and the amount of corrosion of each pair shows very good agreement. The results, after 12 months, are as follows:

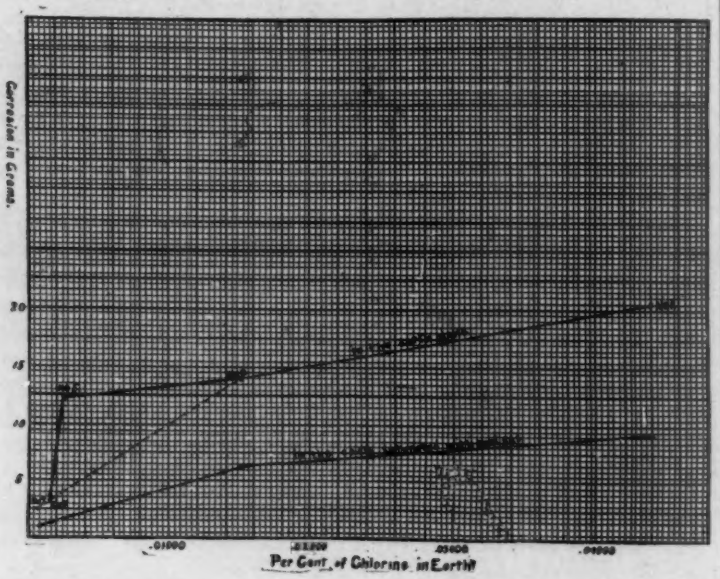
Sample of Earth.	Original Weight of Pipe. Grams.	Final Weight of Pipe. Grams.	Loss of Weight. Grams.	Average Loss of Weight. Grams.
No. 1.....	661.53	652.36	9.17	9.17
" 2.....	658.30	651.77	6.53	6.34
	654.07	647.92	6.15	
" 3.....	663.60	662.45	1.25	1.54
	668.71	666.88	1.83	
" 4.....	665.62	664.37	1.25	1 17
	671.45	670.36	1.09	
" 5.....	653.58	651.78	1.80	1 96
	663.14	661.02	2.12	

The following table shows the comparative amount of corrosion of the pipe in the earth alone and in the earth saturated with coal gas:

Sample of Earth.	Loss of Weight in Earth Alone. Grams.	Loss of Weight in Earth Saturated with Gas. Grams.
No. 1.....	20.56	9.17
" 2.....	13.53	6.34
" 3.....	2.56	1.54
" 4.....	2.51	1.17
" 5.....	(12.40)	1.96

The effect of the gas in retarding corrosion of wrought iron pipe is very marked, especially when we consider that the results showing the corrosion in the earth alone are all low (except No. 5, which is manifestly wrong) because of the failure to maintain the proper amount of moisture in the earths throughout the whole period of the test.

The accompanying chart shows the curves, indicating the relationship between the amount of corrosion and the chlorine content; also the error in No. 5. In the series of experiments with the coal gas, Sample No. 5 shows the normal amount of corrosion. In the series with the earth alone, No. 5 should have shown about 3 instead of 12.40 grams of corrosion. My opinion is that No. 5 was inadvertently subjected to electrolysis, as the appearance of the pipe indicated it and electrolytic experiments were being carried on at the same time.



No. 2 shows a rather high corrosive power in both series of experiments, which is doubtless due to the abnormally high content of nitrogen as nitrates in this sample of earth. It is said that the location from which Sample No. 2 was taken was formerly the site of a livery stable, which would account for the high percentage of nitrates.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

"San Antonio, Tex., always has a spring carnival, and it is usually a big affair; in fact, so attractive is it that other Texans travel many miles to assist in its 'doings.' Naturally such pleasurings cost large sums for arranging and administering, and the cost of this San Antonio example will go well into the thousands. The money is mainly raised by subscription and the canvassers are at work. One of their first efforts was with the proprietors of the San Antonio Gas and Electric Company, and its ally, the San Antonio Traction Company. Both corporations were tractable, and the result was a subscription from them amounting to $800.—L. B. F."

Some days ago the Mayor of Mason City, Ia. (J. H. McCoulogue) vetoed an ordinance adopted by the City Council which put the maximum selling rate for gas by the Mason City Gas Company at $1.40 per 1,000 cubic feet. The Mayor's reasons were that the charge was not based on equitable grounds. The Council, however, would not assent to the Mayor's reasoning, and promptly passed the measure over the veto.

At the annual meeting of the Ludington Gas Company, of Ludington, Mich., the officers chosen were: President, Chas. N. Armstrong; Vice-President, Andrew Fyfe; Secretary, Chas. A. Coye; Treasurer, Geo. M. Leonard.

At the hearing before the Board of Gas and Electric Light Commissioners, on the petition of the Ware (Mass.) Gas Light Company, for an approval of an issue of $15,000 new stock, no testimony in opposition was offered.

The usual quarterly dividend of 1 per cent. on the capital stock of the Consolidated Gas Company, of New York, was made payable the 16th inst.

The Detroit (Mich.) Gas Company has contributed the sum of $500 towards furthering the beneficent purposes of the Darr Mine Relief Committee.

Mr. Robert P. Geer, a prominent merchant of Sansalito, Cal., in consort with other residents of that place, is arranging for the construction there of an up-to-date gas plant.

"B. F. M.," writing from Lansing, Mich., under date of January 31st, says: "An increase of something like 25 per cent. in the business done by the Lansing Fuel and Gas Company is indicated for the year 1907 over 1906. At any rate the sum turned into City Treasurer Bennett, for the twelvemonth ended December 31, 1906, was $2,993, whereas the sum turned in for the last corresponding twelvemonth is $3,816. The royalty is 3 per cent. on the gross."

Representative Shuler has introduced to the attention of the Ohio Legislature a bill which will authorize the ownership and operation of gas and electric lighting plants, with the right to supply private consumers, by the municipal authorites of the State.

Mr. C. H. Pattison, of Kansas City, Mo., is said to be interested in a project to construct and operate a gas works in Corpus Christi, Tex.

Here is an advertising scheme for fair notice. The Jacksonville (Fla.) Gas Company during the last week in January, gave a series of demonstration lectures on how to use gas in the kitchen, and one accompaniment of the demonstration was a luncheon served between the hours of 2:30 and 5:30 P.M. This, of course, was quite a drawing card in itself, but its attractiveness was further abetted by the knowledge that every boy or girl accompanied by either mother, sister, aunt or cousin, would receive a donation in the shape of a large toy balloon. Aeronauts were plentiful in Jacksonville, it is needless to say, the last week in January.

The proprietors of the Wausau (Wis.) Gas Company have announced a reduction in the selling rate of 25 cents per 1,000 cubic feet.

Three thieves were recently convicted of robbing prepayment meter cash boxes in Lynn, Mass. Each was sent to the house of correction for a period of 60 days.

Mr. J. H. Findlay, the proprietor of the Goshen (N. Y.) Illuminating Company, having put the plant in good physical condition, has completed the rejuvenation by opening a handsomely fitted up office in the Drake block. The Company's new quarters are in every re-

spect well fitted to facilitate its business dealings direct with its patrons, in that they are central and attractive and are open for business at hours suited to the best convenience of the people.

"B. S.," WRITING under date of the 4th inst., incloses the following: "Returns just in from the Tri-City Railway and Light Company show considerable improvement in and enlargement of the gas service in Rock Island, Moline and Davenport during the past year. Under the operating and engineering management of Messrs. J. G. White & Co., 37 miles of new 6-inch, 8-inch and 12-inch mains have been laid. The completion of a new 500,000 cubic foot gasholder at Moline, which is part of the system, was recently reported in your columns. The total population served is only about 75,000, so the gas campaign conducted by the White Company's folks has evidently been responded to by a large proportion of the householders in the 'Three Cities,' judging by the demand for the above enlargement of the system."

ANOTHER Company that rejoices in the occupying of handsome, new office quarters is that in Burlington, Ia., whose business headquarters are in the new edifice recently completed under the auspices of The Elks. It is located at the northwest corner of Third and Washington streets, and the Gas Company's quarters take up the entire ground floor of the building.

THE following extracts are from the annual report of the President (Mr. F. N. Dow) to the shareholders of the Portland (Me.) Gas Light Company for the operations of the Company during 1907. The number of consumers on the books, December 31, 1906, was 7,254; December 31, 1907, the number was 7,582, an increase of 328. Of the total meters in use 2,977 were of the prepayment type. The ordinary expenditures on works or plant expenditure amounted, in the ordinary class, to $7,285.65, and to main account (renewals, extensions, etc.) about $20,000—this included the cost of an extension of 3 miles into territory or districts heretofore unsupplied with gas. Speaking in a general way over the business done, President Dow remarks: "The supply of gas was not interrupted, nor was any street light, or for that matter, any other light furnished by this Company, disturbed by any storm, however severe, and this, though streets, stores and houses, lighted under other systems, were sometimes left in darkness through interruption by adverse weather conditions to the service upon which they depended. Thus last year added its testimony to that of others in the past to the reliability of gas lighting. The gas sold and accounted for during the year was 151,231,600 cubic feet, the total of 1906 (141,465,600 cubic feet) being exceeded by 9,766,000 cubic feet. This was a gain of 6.9 per cent. over 1906, as compared with an increase of 7.90 per cent. in 1906 over 1905. This increase in the consumption of gas is largely due to its enlarged use for cooking and for heating purposes. In this connection, however, is to be considered the increased use of our arc lights and other systems of store lighting. These wherever tried have commended themselves as unrivalled in efficiency and economy. The relative excellence, safety and economy of gas as an illuminant have long been known by those well informed about it. But the results of quite recent scientific investigations justify the claim that gas lights in a living room are promotive of health as aiding ventilation and as tending to the destruction of injurious germs. Certain it is that there is at present no convenient method of lighting that will compare in safety and economy with that by gas. Beyond this, daily experience in hundreds of houses in this city is demonstrating to those using it for cooking and for heating, that for those purposes gas is without a successful rival in the establishment and maintenance of the great household trinity, comfort, convenience and cheapness. And it is scarcely too much to say that the house that is without a gas range, a gas water heater and radiators of some form for use for heating, at least in Spring and Fall, is not well appointed. And to a growing appreciation of these facts upon the part of many of our citizens is to be attributed much of the increased output of gas in recent years. This is due to the fact that gas appliances have been so increased in variety and improved in the matter of efficiency and economy as to make the use of gas much more convenient and much less expensive than in the past. The increasing demand for gas promises well for the Company and for the community. For the Company, because in that direction its prospective profits are to be found. For the community, for through such increase is the highway to cheaper gas. It is clear that a large demand for gas can be supplied at less per 1,000 than a small output costs. And the directors would be glad of the co-operation of the city as a municipality and of our citizens as individuals to this end. Should the directors receive the assistance of the city and of citizens in this policy, which would seem to be for the benefit of city, citizen and Company alike, larger dividends for the stockholders, of which the city as a municipality is the largest, and lower prices for consumers would naturally result. An increased output in a way not materially increasing the cost of distribution tends, of course, toward a lower average cost of production per 1,000. But that tendency has been to a great extent offset this year by the increased cost of labor and material. And it is a curious phase of the natural desire and laudable effort for increased wages that they are frequently attended by persistent protests against the inevitably resulting increased cost of the products of labor. It is to be borne in mind that a considerable proportion of our increased output in recent years has been secured through the addition to our customers of many whose consumption, though considerable in the aggregate, is individually so small as to make the margin for profit upon what the Company supplies them very slight. Indeed, in many instances the balance is on the wrong side. Many do not seem to understand that to maintain a service to a meter, to read, and to care for a meter, to keep all the accounts and to do all the work entailed by it, costs the Company as much when that meter registers an annual consumption for which the Company receives but $3.75 a year, as it would if that meter served a customer who consumed 5, 10 or 50 times as much gas. In the case of such a small consumption there is no profit to the Company. Nevertheless its management deems it proper to give respectful consideration, and to make every effort to respond favorably to an application for the smallest quantity of gas. And, in view of the peculiar relation of this Company to the city, there are probably few of our stockholders who will question the reasonableness of this policy." The report also recommends that improvements needed on the plant, and which should be made as soon as possible, include additional retort capacity, water gas purifiers, rotary washer, oil storage tank, a new gasholder and a shaving scrubber. Engineer Yorke says that the latter should be put in at once.

THE receivers appointed the last week in January to care for the affairs of the Suffolk (Va.) Gas Company, the plant of which is in course of construction, have given the contract for its completion to Mr. F. D. Moses, of Trenton, N. J. The plant, under the agreement with Mr. Moses, is to be completed in 65 days. Mr. W. H. Fritchman is the engineer for the receivers.

MR. EDWARD E. KING, who recently resigned the position of Treasurer to the North Attleboro (Mass.) Gas Company, has been succeeded by Mr. Edwin A. Codding.

MR. MICHAEL O'MALLEY has been appointed Superintendent of the Great Falls (N. H.) Gas Light Company, vice the late Mr. F. G. Chapman.

THE City Commission, of Fort Worth, Tex., threatens to engage in the construction and operation of a gas plant on municipal account.

THE State Railroad Commission, of Georgia, will to-morrow hear argument on the petition of ex-Councilman W. H. Terrell, of Atlanta, for a revision of the rates that may be charged by the Georgia Rail way and Electric Company and the Atlanta Gas Light Company.

ACCORDING to Associated Press despatches in the newspapers of the 2d inst., although gross earnings of the Philadelphia Company and its affiliated corporations were $19,091,423, nevertheless there was a decrease in its net earnings for the last calendar year of $91,000. The Company says this is due to increased operating expenses caused by higher wages and greater cost of materals. A reduction in fixed charges was accomplished by cutting down the amount of outstanding stocks of subsidiary corporations, the reduction amounting to $191,646. Earnings available for the common stock, without deducting for betterments and extensions usually charged against income by this Company, amounted to $2,631,869, for 1907, equal to about 8 per cent. on the common stock. The highest rate ever shown in any one calendar year was in 1903, when it was 9.02 per cent. Recent discoveries in gas territory are expected to add to the parent Company's earnings in the current year.

DESPATCHES from Cedar Rapids, dated the 30th ult., are to the effect that the District Court on that date issued an order dissolving the injunction obtained by the Cedar Rapids Gas Company to restrain the enforcement of an ordinance obliging the Company to charge not in excess of 90 cents per 1,000 cubic feet.

THIS story, if narrated in a work of fiction, would be considered entirely a product of the author's imagination, whereas it is an actual up-to-date occurrence - the narrative is from a recent issue of the Chicago "Journal:" "Belief that Dr. Frank Dobija, who is thought to be dying at the Alexian Brothers' hospital as the result of gas asphyxiation, was the victim of a negro robber, to-day caused a search by detectives in the physician's rooms, 241 North avenue. Dr. Dobija, who is reputed to be worth about $80,000 and is said to have been in the habit of carrying from $400 to $500 on his person, was found unconscious in his room with two gas jets turned on. Only $5 was in his pockets. There was no sign of a struggle. The clew which leads the police to believe that a robbery was committed is the statement of Mrs. Margaret Fisher, who lives in the flat below, that she saw the Doctor pay a negro $50 for a bed which was delivered to the room last Wednesday. He took the $50 bill from a large roll in which, she says, there must have been several hundred dollars. The negro eyed the money intently. She also saw the negro loitering in the neighborhood later. Since Friday (Jan. 28) Dr. Dobija had not been seen and he had failed to keep a number of appointments. About 2 hours before he was found unconscious a searching party had entered his room and saw him apparently asleep. Mrs. Fisher and Prof. A. Barker, a translator of languages, who led the investigation, affirm that no gas was escaping in the room at the time. Later, when Dr. A. W. Thimm, 370 Dearborn avenue, went to the room and could not gain admittance, the police of the Hudson street station, who broke open the door, found gas escaping from open gas light jets and a gas stove. The supposition is that the negro waited until the Doctor was asleep, then entered the room and again waited until the Doctor would be unconscious. It was then an easy matter for the thief to complete the robbery, turn on the gas and leave the room unnoticed."

THE AMERICAN GAS LIGHT JOURNAL

A. M. CALLENDER & CO.,
PROPRIETORS.

THOS. J. CUNNINGHAM,
ELBERT P. CALLENDER,
EDITORS.

PUBLISHED ON EACH MONDAY OF THE YEAR AT
No. 42 Pine Street, New York.
Telephone, 2996 John.

TERMS:

SUBSCRIPTION—Three Dollars per annum, in advance, Single copies, 10 cents.

The JOURNAL is the official organ of the NEW ENGLAND ASSOCIATION OF GAS ENGINEERS.

NOTIFICATION RESPECTING ADVERTISING.

Orders for new advertising, or for changes in standing advertisements, to insure attention in the issue following their reception, must be in hand any time of Wednesday.

AGENTS:

New York—American News Company, 39 and 41 Chambers street.
Germany—Lemcke & Buechner, of New York.
England—Aug. Siegle, 30 Lime street, London.

MONDAY, FEBRUARY 10, 1908.

The Market for Gas Securities.

The market for city gas shares was very narrow this week, and the general tendency was to lower prices. Consolidated opened today (Friday) at 97 to 97¼, with only perfunctory bids, however. It should be remembered that the stock is now dividend-on of 1 per cent.

In out-of-town shares dullness reigns, although prices are fairly well maintained, especially in respect of Peoples, of Chicago, which remains at the decidedly inviting bid figure of 85¼. Massachusetts Companies remains at the figures quoted last week—the preferred here too looks decidedly a purchase. The gas bond market continues firm.

Gas Stocks.

Quotations by George W. Close, Broker and Dealer in Gas Stocks.

16 WALL STREET, NEW YORK CITY.

FEBRUARY 10.

☞ All communications will receive particular attention.

☞ The following quotations are based on the par value of $100 per share:

N. Y City Companies.	*Capital.*	*Par.*	*Bid.*	*Asked.*
Consolidated	$73,177,000	100	97	97¼
Central Union Gas Co.—				
1st 5's, due 1972, J. & J	2,000,000	1,000	92	97
Equitable Gas Light Co.—				
Con. 5's, due 1932, M. & S.	1,000,000	1,000	—	105
Mutual	3,500,000	100	—	170
New Amsterdam Gas Co.—				
1st Con. 5's, due 1948, J. & J.	11,000,000	1,000	85	90
New York & Richmond Gas Co. (Staten Island)	1,500,000	100	37	43
1st Mtg. Gold Bds. 5 p. ct.	1,000,000	—	98	104
Northern Union—				
1st 5's, due 1927, J. & J.	1,250,000	1,000	90	98
New York and East River—				
1st 5's, due 1944, J. & J.	3,500,000	1,000	100	105
Con. 5's, due 1945, J. & J.	1,500,000	—	97	101
Standard	5,000,000	100	70	100
Preferred	5,000,000	100	100	125
1st Mtg. 5's, due 1930, M. & N.	1,500,000	1,000	100	105
The Brooklyn Union	15,000,000	1,000	90	100
1st Con. 5's, due 1948, M. & N.	15,000,000	—	91½	92
Yonkers	299,600	500	130	—
Out-of-Town Companies.				
Bay State	50,000,000	50	½	¾
" Income Bonds	2,000,000	1,000	—	75
Binghampton Gas Works	450,000	100	—	65
" 1st Mtg. 5's	500,000	1,000	95	100
Boston United Gas Co.—				
1st Series S. F. Trust	7,000,000	1,000	82	85
2d " " "	3,000,000	1,000	47½	50
Buffalo City Gas Co.	5,500,000	100	5	8
" " Bonds, 5's	5,250,000	1,000	63	66
Capital, Sacramento	500,000	50	—	35
Bonds (6's)	150,000	1,000	—	—
Chicago Gas Co. Guaranteed Gold Bonds	7,000,000	1,000	104	103¾
Cincinnati Gas and Electric Co.	20,500,000	100	93	93¼
Columbus (O.) Gas Co., 1st Mortgage Bonds	1,500,000	1,000	92	98
Columbus (O.) Gas Lt. & Heating Co.	1,682,750	100	87	88
Preferred	3,026,500	100	81	83
Consumers, Toronto	2,000,000	50	200	204
Consolidated, Baltimore	11,000,000	100	—	90
Mortgages, 6's	3,600,000	—	—	118
Chesapeake, 1st 6's	1,000,000	—	—	—
Equitable, 1st 6's	910,000	—	—	—
Consolidated, 1st 5's	1,490,000	—	—	113
Consolidated Gas Co. of N. J.	1,000,000	100	15	17
Con. Mtg. 5's	880,000	1,000	92	95
Bonds	75,000	—	—	100
Detroit City Gas Co.	6,000,000	50	—	50
" Prior Lien 5's	4,618,000	1,000	—	98
Detroit Gas Co., 5's	881,000	1,000	75	80
" Inc. 5's	16,000	100	98½	100
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1,000	—	101
Essex and Hudson Gas Co.	6,500,000	—	39	40
Fort Wayne	2,000,000	—	—	—
" Bonds	2,000,000	—	55	—
Grand Rapids Gas Lt. Co., 1st Mtg. 5's	1,225,000	1,000	104½	105
Hartford	750,000	25	190	200
Hudson County Gas Co., of New Jersey	10,500,000	—	100	105
" Bonds, 5's	10,500,000	—	101	102½
Indianapolis	2,000,000	—	60	70
" Bonds, 5's	2,650,000	—	104½	105
Jackson Gas Co.	250,000	70	82	—
" 1st Mtg. 5's	250,000	1,000	97	100
Kansas City Gas Light Co., of Missouri	5,000,000	100	—	36
Bonds, 1st 5's	3,822,000	1,000	102	104
Laclede, St. Louis	10,000,000	100	97	97¼
Preferred	2,700,000	100	92½	93
Bonds	10,000,000	1,000	104	104¼
Lafayette Gas Co., Ind.	1,000,000	100	—	60
Bonds	1,000,000	1,000	60	65
Louisville	2,570,000	50	143	145
Madison Gas & Elec. Co.				
" 1st Mtg. 6's	350,000	1,000	106	108½
" 6 per cent. scrip, due 1910	100,000	25	60	60½
Massachusetts Gas Companies, of Boston	25,000,000	100	53	53¼
Preferred	25,000,000	100	83	83¼
Montreal, Canada	2,000,000	100	214	218¾
Nashville Gas Lt. Co.	1,000,000	100	110	—
Newark, N. J., Con. Gas Co.	6,000,000	—	86	88
Bonds, 6's	6,000,000	—	137	138
New Haven	2,000,000	25	200	—
Peoples Gas Lt. & Coke Co., Chicago	25,000,000	100	85¼	85½
1st Mortgage	20,100,000	1,000	—	—
2d "	2,500,000	1,000	104	—
Rochester Gas & Elec. Co.	2,150,000	50	88	—
Preferred	2,150,000	50	118	—
Consolidated 5's	2,000,000	—	104½	105½
San Francisco, Cal.	15,500,000	—	—	—
St. Joseph Gas Co.—				
1st Mtg. 5's	751,000	1,000	92	—
St. Paul Gas Light Co.	1,500,000	100	45	47
1st Mortgages, 6's	620,000	1,000	113	114
Extension, 6's	600,000	1,000	112½	115
General Mortgage, 5's	2,465,000	1,000	96¼	—
Syracuse, N. Y.	1,975,000	100	50	55
Bonds	2,047,000	1,000	102	—
Washington, D. C.	2,000,000	20	340	345
1st Mortgage, 6's	600,000	—	—	—
Western, Milwaukee	4,000,000	—	—	—
Wilmington, Del.	600,000	50	220	—

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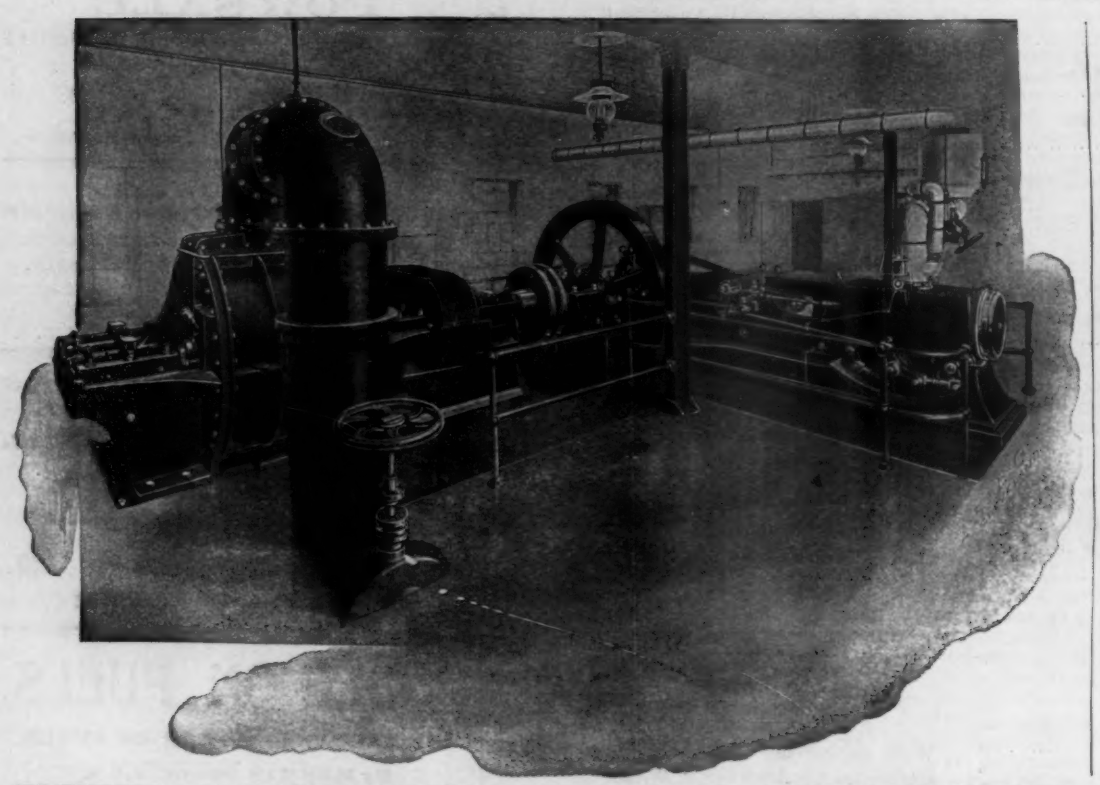

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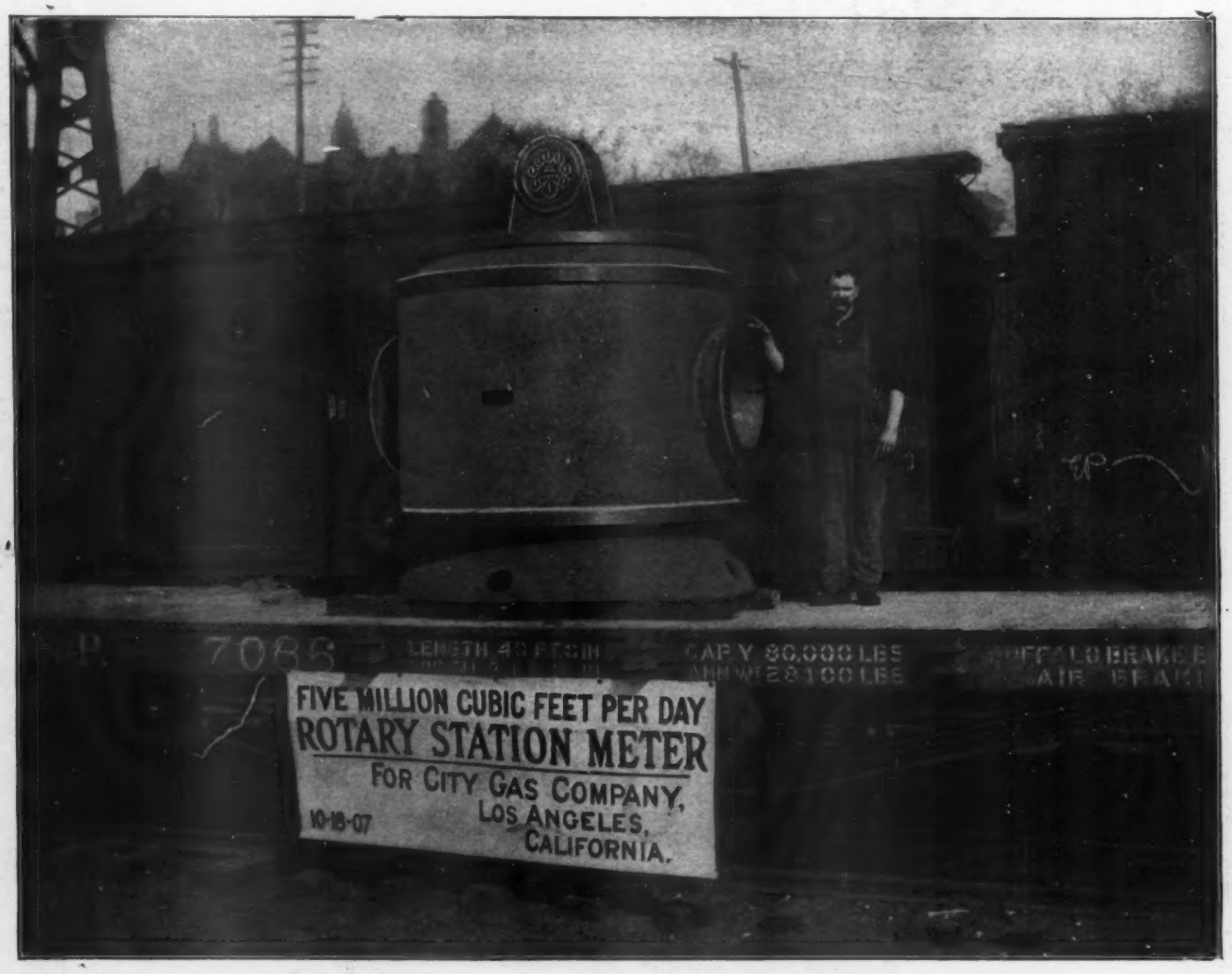
EUROPEAN CONNECTIONS:

The Rotary Meter Co. (1905) Ltd., Manchester, England.
Compagnie pour la Fabrication des Compteurs et Materiel d'Usines a Gaz, Paris, France.



24-inch connections; 84-inch face to face flanges; 90 inches floor to center of dial.

The 5,000,000 Cubic Foot Per Day
ROTARY STATION METER

On Car for City Gas Company, Los Angeles, California.

OCTOBER 22d, 1907, we received an order from, and are now building, a **ROTARY STATION METER** of 4,000,000 cubic feet per day for the **Brooklyn Union Gas Co.**, to be installed in its **Nassau Wo ks!**

OCTOBER, 1906, the **Consolidated Gas Co., of New York City,** installed in its **21st Street Works** a **ROTARY STATION METER** of 4,000,000 cubic feet per day!

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ROTARY METER COMPANY

One-half the cost—One-tenth the space of old style wet meters.

When in need of Station Meters, write

ROTARY METER COMPANY,

280 Broadway,
NEW YORK.

Send for Catalog.

P. PLANTINGA, President. W. E. STEINWEDELL, Secretary.

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Main Office and Shops

CLEVELAND, OHIO.

NEW YORK OFFICE, - - 56 PINE STREET.

COAL AND WATER GAS APPARATUS.

EXHAUSTERS, CONDENSERS, SCRUBBERS,
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BY PRODUCT MACHINERY,
COMPLETE GAS PLANTS.

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SELF-SEALING BRIDGE PIPES.

THE GAS MACHINERY CO.
CLEVELAND, OHIO.

ANNOUNCEMENT.

January 1st, 1908.

TO OUR PATRONS AND FRIENDS:

Our new Firebrick Factory has been completed and we are now ready to take orders for high-grade fireclay products of any description and magnitude. We design and build

Coal Gas Benches,

VERTICAL, INCLINED OR HORIZONTAL RETORTS,

LATEST PATENTED SYSTEMS.

Coke Ovens,

BEEHIVE AND BY-PRODUCT CONSTRUCTION.

Manufacture Linings for Water Gas Apparatus, Rotary Cement Kilns, Blast Furnaces and Stoves, Steel Furnaces, Lime Kilns, Cupolas, etc., etc.

SPECIAL GLASS HOUSE REFRACTORIES.

WE IMPORT THE FINEST FIRECLAY FOR SPECIAL HIGH GRADE WORK.

Our Chemist Engineers are familiar with analyzing clays and producing mixtures so that the finished products will answer specific purposes with regard to refractory as well as physical properties.

ALL MATERIAL OF THE VERY BEST QUALITY AND WILL BE SOLD AT THE LOWEST PRICES PERMISSIBLE.

Your Correspondence is Respectfully Solicited.

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Bench construction of most modern type, with horizontal, inclined and vertical retorts, together with retort houses, coal and coke handling machinery, specially designed to suit the characteristic requirements of the benches.

CONSULTING AND CONSTRUCTING ENGINEER.

Plans for modern and up-to-date coal and water gas plants. Modernizing existing plants to cheapen costs of production. Valuation of plants, etc., etc.

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"CHRISTY PLANT," FORMERLY CHRISTY FIRECLAY CO.

"LACLEDE-CHRISTY" GAS ENGINEERS.

"LACLEDE PLANT," FORMERLY LACLEDE FIREBRICK MFG. CO.

OUR ENGINEERING DEPARTMENT IS EQUIPPED TO DESIGN, CONTRACT FOR AND BUILD COMPLETE GAS PLANTS FROM BREAKING OF GROUND TO MAKING GAS.

IF YOU WANT { DESIGN, MATERIAL, WORKMANSHIP, BENCHES, RESULTS, } THE BEST

COMMUNICATE WITH

LACLEDE-CHRISTY CLAY PRODUCTS CO.,

ST. LOUIS, MO.

"EVERYTHING THAT IS MADE FROM CLAY."

Ramsdell

ONE-HALF ACTUAL SIZE.

This is the BIJOU.

This is the Ramsdell No. 6 Bijou—the little giant that produces 20 candles of light on a consumption of only one foot of gas per hour.

The small size and artistic design of the Bijou make it by far the best lamp under many conditions. Particularly for application to ordinary upright fixtures and for residential chandeliers.

The No. 6 Bijou is equipped with the new double mixing chamber. The list price is $1.50, Boxed complete, with globe, mantle and adapter.

The Bijou must be seen to be properly appreciated. SHOW it to your customers and note their verdict.

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Geo. G. Ramsdell, President,

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BEST IN THE WORLD.

THAT MEANS THE

Humphrey Instantaneous Bath Water Heaters.

They should be used in every home, no matter whether there are other hot water arrangements or not. ∴ ∴ ∴ ∴ ∴ ∴ ∴

Handsome New Catalog No. 9 is Free. Shall we Send it? ∴ ∴

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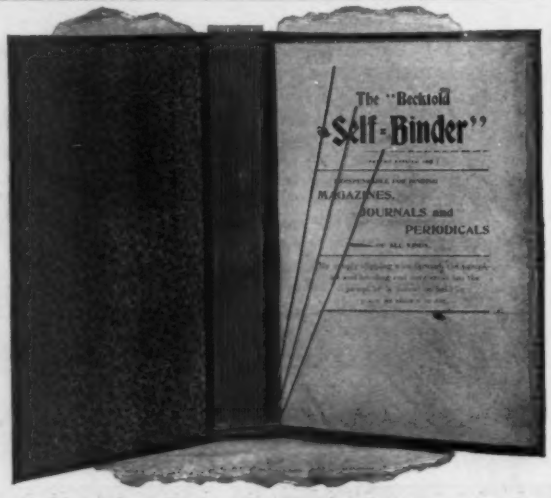
Kalamazoo, Mich., U. S. A.



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YORK GAS RANGES FOR 1908

Have the Safety Open Door Lighter for oven burners. This safety lighting device absolutely does away with all liability of ovens exploding.

York and New-York Gas Ranges for this Season

HAVE ALL THE GOOD POINTS OF THE UP-TO-DATE RANGES.

CATALOG WILL BE READY FEBRUARY 1ST.

If you have been dissatisfied with your Stove Tubing, try the Atlantic Tubing Company's Special Stove or Safety Stove Tubing. We sell it in any quantity.

Let us send you samples of Gas Brackets.
Let us quote you on contract Gas Fixtures.
Let us quote you on Special Appliances.
Let us quote you on Flexible Metal Tubing.
Let us quote you on Automatic Soldering Furnaces.
Let us quote you on Hot Plates.
Let us quote you on Art Glass Domes and Shades.

FRED. K. WELLS COMPANY,

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Selling Agents of Gas Appliances, Etc., Etc.

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HENRY W. SCATTERGOOD, Vice-President and Treasurer.
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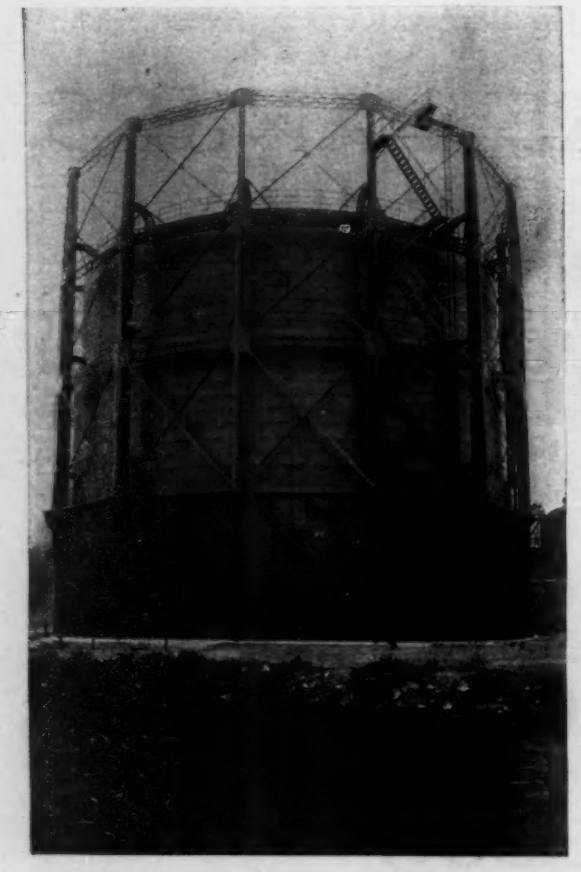
616 The Rookery, Chicago, Ills.

Pacific Coast Agents:
HALLIDIE MACHINERY CO.,
Seattle, Wash.



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WORKS:
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Manufacturers of

TRIPLE
DOUBLE and
SINGLE-LIFT

Gas Holders,

WITH OR WITHOUT
METAL TANKS.

Oil and Water Tanks,
Purifier Covers,
General Plate Metal Work, and
Steel Water Towers.

PLANS, SPECIFICATIONS AND ESTIMATES
PROMPTLY FURNISHED ON REQUEST.

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BENCH WORK

CHARGING AND
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MACHINERY

MACKENZIE
EXHAUSTERS

PRIMARY AND
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CONDENSERS
FOR FRESH
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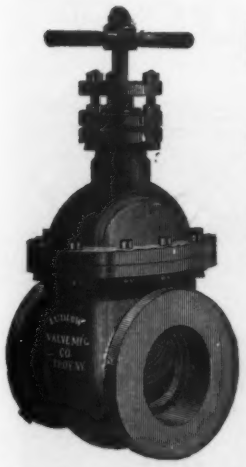

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Ludlow Valve Mfg. Co.,

TROY, N. Y., U. S. A.

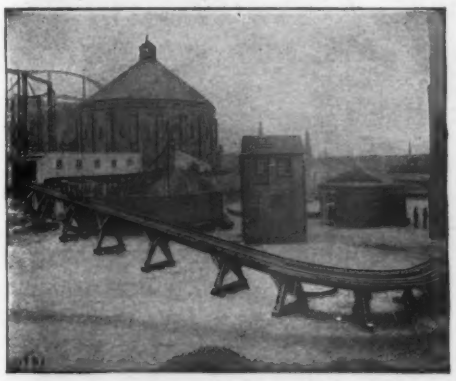
Double and Single Gate Valves, ¼" to 72",

—FOR—

Gas, Water, Steam, Oil, Ammonia, Etc.

HOT GAS VALVES A SPECIALTY.

Send for Catalogue.



HUNT CABLE RAILWAYS

For Handling Coal and Coke in Gas Works.

The cost of handling coal and coke by this method is only the expense of loading the cars (one man) and the power to drive the cable. Every inch of ground is available, as the space under the trestles can be utilized for storage, if necessary. These railways are built of different types, to handle any quantity of material, large or small.

If you are interested in the subject, we will take pleasure in sending you photographs of some of the plants we have installed upon receipt of your card, and will give such information as is in our power if you will let us know your requirements.

C. W. HUNT CO., West New Brighton, N. Y. 45 Broadway, New York.

ARTHUR E. BOARDMAN, C.E.,

For several years associated with the late CAPTAIN WILLIAM HENRY WHITE,

WILL CONTINUE THE BUSINESS OF

CONSULTING ENGINEER

For Gas, Water and Electric Light Companies, at No. 41 Wall Street, Room 1707, New York.

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REG. U. S. PAT. OFFICE.

RECORDING GAUGES,

THE STANDARD FOR GAS WORK ON HIGH OR LOW PRESSURE.

For Works and Distribution System.

We offer the following types in all ranges:

Standard Form
Portable Form,
Moisture Proof.

ASK FOR CATALOGUE A.

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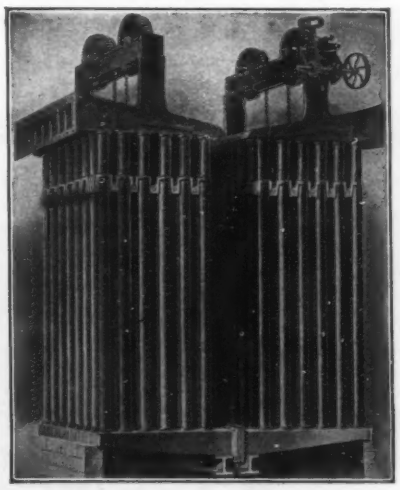
Waterbury, Conn., U. S. A.

NEW YORK: 114 Liberty St. CHICAGO: Monadnock Bldg.



HOW MUCH COAL PER 1,000 CU. FT. OF WATER GAS?

If the process of making water gas were theoretically perfect, only 24 lbs. of coal would be consumed per 1,000 cu. ft. of gas generated. As a matter of fact, the actual figures are between 40 and 48 lbs. per 1,000 cu. ft. It is appar nt that there is a waste somewhere, and if you will take the trouble to put a thermometer over the stack valve during the "blowing up" period, you will see where the heat goes to. From one third to one half of the heat escapes to the atmosphere, either as sensible heat or latent heat of combustion. If use can be found for this heat a great economy could be effected immediately.

We have found such a use. By means of the Green Air Heater 12 per cent. to 15 per cent. of this heat, or more, can be imparted to the a'r blown to the generator. This will reduce the time for blowing up and increase the temperature of the generator, so that about the same proportion of coal will be saved.

After the gases have passed through the air heater they are still hot enough to use in a Green Fuel Economizer to heat the boiler feed water up to the evaporative point. In this way a quarter of the boiler coal can be saved. In connection with a 6 ft. generator an investment of $3,500 in an Air Heater and an Economizer will save from $2,300 to $2,500 per year. This ought to repay you for the trouble of writing us for further information. Ask for Circular "AG."

The Green Fuel Economizer Co.,

MATTEAWAN, N. Y.

New York City, Boston, Chicago, Atlanta, San Francisco, Los Angeles, Seattle, Salt Lake City, Montreal.

Engineers, Builders of Green's Fuel Economizers, Fans, Blowers and Exhausters, Steam Air Heater Coils, Waste Heat Air Heaters, Mechanical Draft, Heating and Ventilating and Drying Apparatus, Draft Dampers and Engines.

12-Inch High Pressure Governor.

REYNOLDS' GAS REGULATOR COMPANY,

ANDERSON, IND., U. S. A.

We make all sizes for all classes of reduction,

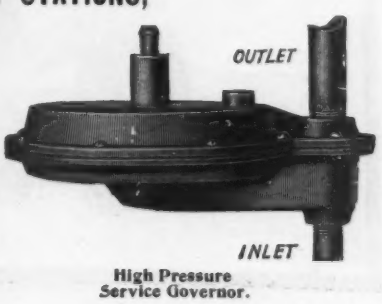
DOUBLE and SINGLE DISTRICT STATIONS,

And Individual Service Governors for Reducing High Pressure.

HOLDER GOVERNORS

And Low Pressure Regulators, all of the Dry Diaphragm type.

Write for Catalog.



High Pressure Service Governor.

LLOYD CONSTRUCTION COMPANY
THE LLOYD INTENSIVE SCRUBBER.
DETROIT—MICHIGAN

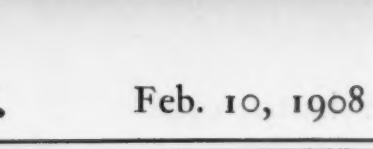
"The Stationary Rotary."

ONE SECTION

out of use does not interfere with the others working.

MUELLER

GAS UNION METER COUPLINGS AND SOLDERING NIPPLES.



Illustrations show five patterns of Union Meter couplings and two of our eighteen patterns of Soldering Nipples.

Made of red brass, accurately threaded, good length and good thickness.

Unconditionally Guaranteed.

MUELLER

H. MUELLER MFG. CO,

Works and General Offices,
DECATUR, ILL., U. S. A.
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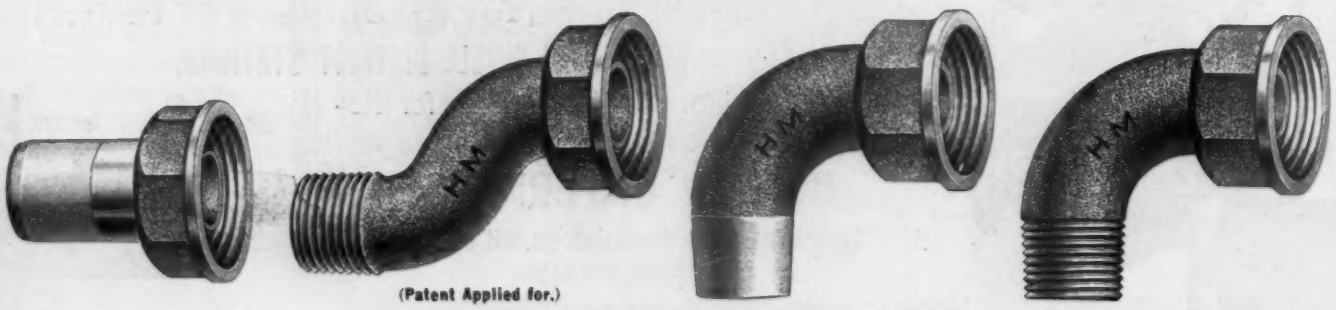
Eastern Division,
NEW YORK, N. Y., U. S. A.
254-258 Canal St. (cor. Lafayette).



(Patent Applied for.)

ROOTS' GAS EXHAUSTERS.

Installation showing our latest improved machines, with flexible rope coupling, for large units.

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You find
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Because every fabric, every color scheme, every article gets it's true color value
THE MERCHANT ALSO IS GETTING THE CHEAPEST STORE ILLUMINATION TO BE HAD AND THE BEST AS WELL

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DONALDSON IRON COMPANY. EMAUS, PA.

MANUFACTURERS OF

CAST IRON PIPE AND SPECIAL CASTINGS

FOR WATER AND GAS.

Also, FLANGE PIPE, LAMP POSTS, Etc.

WILLIAM H. BRISTOL,
COMBINATION RECORDING and INDICATING PYROMETERS
for
WATER GAS MACHINES.

Indicator for Operator. Recorder for Superintendent. Adapted for both Carbureter and Superheater.

Send for Circular and List of Users.

WM. H. BRISTOL,
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"THE MINER"
Globe Street and Boulevard Lamps.
Cheapest and Best
THOUSANDS IN USE WITH INCANDESCENT BURNERS.
Send for Catalogues.
THOMAS T. W. MINER,
821-823 Eagle Av., N.Y.

Bray's Union-Jet.

ASK ANY GAS COMPANY WHO USES BRAY BURNERS WHY THEY USE THEM,

And their answers would contain more reasons than would fill this page. Reduced to a few words it would be—

Because they are more durable. They reduce complaints, and they bring out the full value of the gas.

Could you ask for better reasons?

OUR BLUE BOOK WOULD INTEREST YOU. May we send it?

W. M. CRANE COMPANY,
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We make Gas Appliances of all kinds. SOLE AGENTS for BRAY BURNERS for the UNITED STATES and CANADA.

Self-Lighting Burner.

PARKER-RUSSELL MINING AND MFG. CO.,
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GAS RETORT BENCHES, STOKING MACHINERY, STAND-PIPE CLEANER AND STRAIGHT STAND-PIPE SYSTEM.

GAS RETORTS AND FIREBRICK.

We Manufacture Gas Retorts and Settings, Furnace Blocks and Fire Clay Tiles of Every Description.

Benches.--We erect GAS RETORT BENCHES with Horizontal retorts having closed ends up to 10 feet in length, or Through retorts up to 20 feet in length.

Slopers.--Also, SLOPERS on improved lines for Inclined Retorts.

Stoking Machinery.--Sole Agents for U. S. and Canada for the Fiddes-Aldridge Simultaneous Discharging Charger. The "F. A.," or "One-Stroke" Machine. Cost of Carbonizing reduced to minimum. No Dust. Silent. No Waste of Coal. No Injury to Retorts.

Water Gas Linings.--We make a specialty of WATER GAS BLOCKS, and supply brick of superior grade for checkerwork.

Stand-Pipe Cleaner and Straight Stand-Pipe System.--Agents for the sale of the Stand-Pipe Cleaner and Straight Stand-Pipe System of the United Gas Improvement Company.

Retort Houses and Conveying Machinery.--We also build Retort Houses, Coal and Coke Conveying Machinery. Plans, specifications and estimates cheerfully furnished.

CORRESPONDENCE SOLICITED.

ALL CONTRACTS MADE AS OF ST. LOUIS.

Directory of American Gas Companies, 1907. **Price, $5.00.**
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AMERICAN METER CO.,

NEW YORK, ST. LOUIS, PHILADELPHIA, SAN FRANCISCO, CHICAGO,

Photometrical and Experimental Apparatus.

PUBLIC LIGHTING TABLE.

FEBRUARY, 1908.

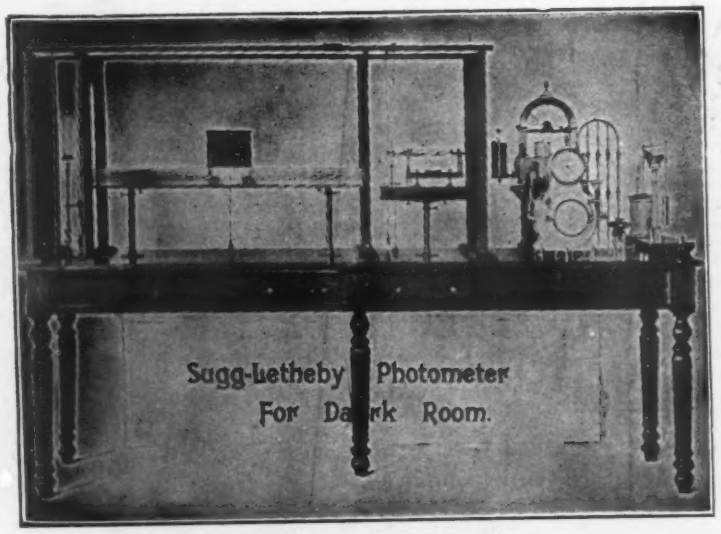
Table No. 1.
FOLLOWING THE MOON.

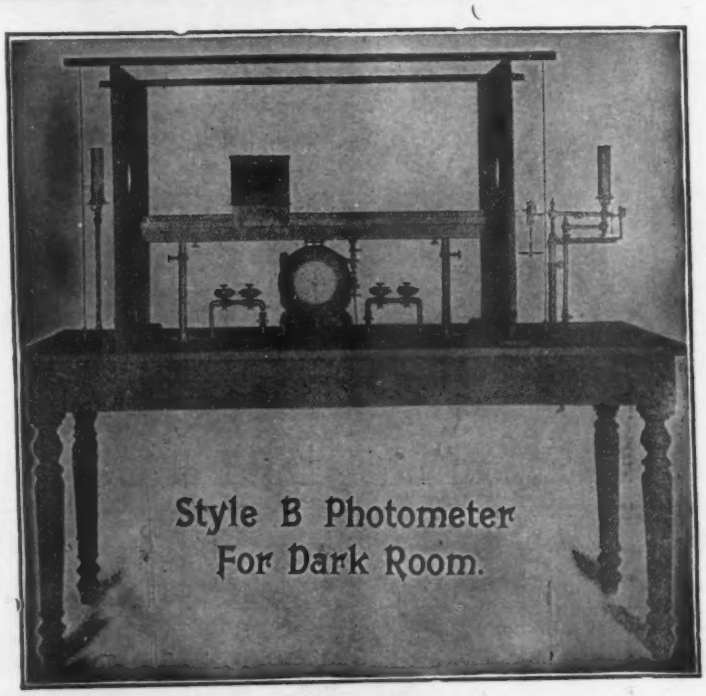
Day of Week.	Date.	Light.	Extinguish.
Sat.	1	5.40 PM SM	6.10 AM
Sun.	2	5.50	6.10
Mon.	3	5.50	6.10
Tue.	4	5.50	6.10
Wed.	5	5.50	6.10
Thu.	6	9.40	6.10
Fri.	7	10.40	6.10
Sat.	8	11.50 FQ	6.10
Sun.	9	12.50 AM	6.00
Mon.	10	1.50	6.00
Tue.	11	2.50	6.00
Wed.	12	3.40	6.00
Thu.	13	4.30	6.00
Fri.	14	5.10	6.00
Sat.	15	No L.	No L.
Sun.	16	No L. FM	No L.
Mon.	17	No L.	No L.
Tue.	18	6.10 PM	8.00 PM
Wed.	19	6.10	8.50
Thu.	20	6.10	9.50
Fri.	21	6.10	11.00
Sat.	22	6.10	12.00
Sun.	23	6.20	1.00 AM
Mon.	24	6.20 LQ	2.10
Tue.	25	6.20	3.20
Wed.	26	6.20	4.20
Thu.	27	6.20	5.30
Fri.	28	6.20	5.40
Sat.	29	6.20	5.40

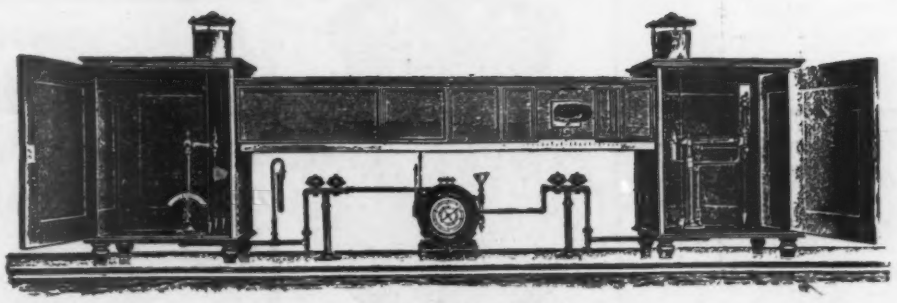
TOTAL HOURS DURING 1908.

By Table No. 1.

	Hrs. Min.
January	228.30
February	187.30
March	192.00
April	160.10
May	155.10
June	138.00
July	155.50
August	173.40
September	185.20
October	214.00
November	218.10
December	226.40
Total, yr.	2235.00







Closed Photometer For Light Room.

CIRCULARS SENT ON REQUEST.

PUBLIC LIGHTING TABLE.

FEBRUARY, 1908.

Table No. 2.
NEW YORK CITY.
ALL NIGHT LIGHTING.

Day of Week.	Date.	Complete Lighting in One Hour (From Time Given P. M.)	Complete Extinguishing in 50 Minutes (From Time Given A. M.)
Sat.	1	4.47	6.07
Sun.	2	4.47	6.07
Mon.	3	4.47	6.07
Tue.	4	4.47	6.07
Wed.	5	4.57	6.02
Thu.	6	4.57	6.02
Fri.	7	4.57	6.02
Sat.	8	4.57	6.02
Sun.	9	4.57	6.02
Mon.	10	4.57	6.02
Tue.	11	4.57	6.02
Wed.	12	5.07	5.57
Thu.	13	5.07	5.57
Fri.	14	5.07	5.57
Sat.	15	5.07	5.57
Sun.	16	5.07	5.52
Mon.	17	5.07	5.52
Tue.	18	5.07	5.52
Wed.	19	5.17	5.47
Thu.	20	5.17	5.47
Fri.	21	5.17	5.47
Sat.	22	5.17	5.47
Sun.	23	5.17	5.42
Mon.	24	5.17	5.42
Tue.	25	5.17	5.42
Wed.	26	5.22	5.32
Thu.	27	5.22	5.32
Fri.	28	5.22	5.32
Sat.	29	5.22	5.32

TOTAL HOURS DURING 1908.

	Hrs. Min.
January	481.50
February	329.15
March	351.50
April	341.50
May	233.05
June	218.10
July	282.55
August	254.55
September	292.25
October	420.45
November	374.30
December	411.05
	3992.35
Deduct on account of 50 min. extinguish'ng time	30.30
Total, yr.	3962.05

NEW YORK, 318 West 42d Street.
BOSTON, 820 Beacon Building.
PHILADELPHIA, Broad and Arch Streets.
ST. LOUIS, 712 Roe Building.
CHICAGO, 218 La Salle Street.
SAN FRANCISCO, 512 Oak Street.

WELSBACH STREET LIGHTING COMPANY

....OF AMERICA....

No. 36.

Controls and Operates the **Welsbach System of Street Lighting,**

Which includes its specially DESIGNED and PATENTED BURNER for PARK LIGHTING exclusively.

Uniformly SUCCESSFUL in 150 Cities and Towns.

By means of the Welsbach System of street lighting the superiority of GAS over electricity for street lighting has been fully demonstrated.

POINTS OF MERIT:

It is { Economical, Attractive, Successful, Up-to-date.

IT LIGHTS THE STREET.

Where there are no gas mains we can furnish an equally good light by our SELF-GENERATING NAPHTHA WELSBACH BURNER, and thereby supply a uniform light in all localities.

Correspondence Solicited from Gas Companies and Others interested in Municipal and Outside Lighting.

No. 38.

INVERTED REFLEX TRADE MARK GAS LIGHT

Succeeds and Excels the Electric Light at One-Quarter the Cost.

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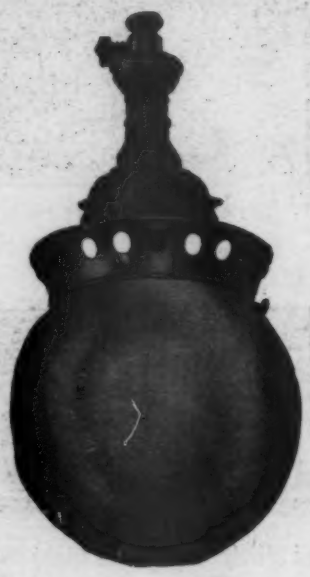

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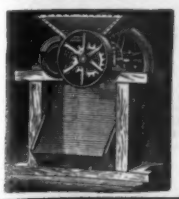

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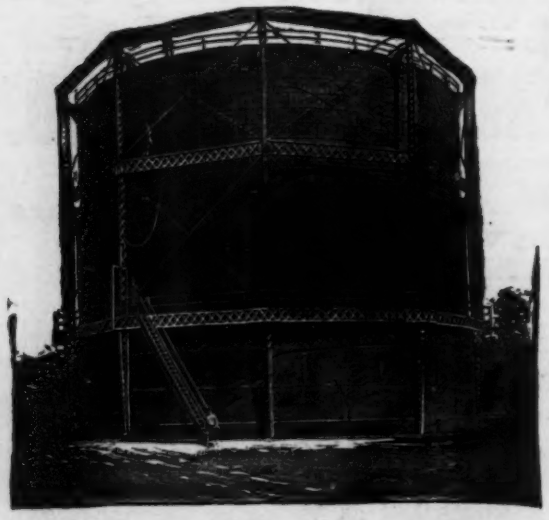

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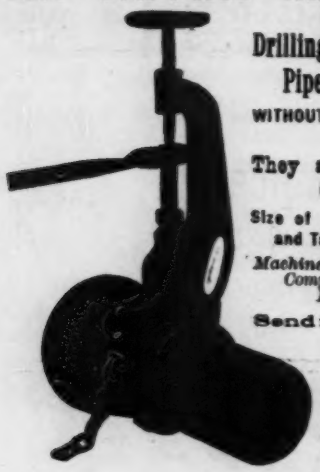

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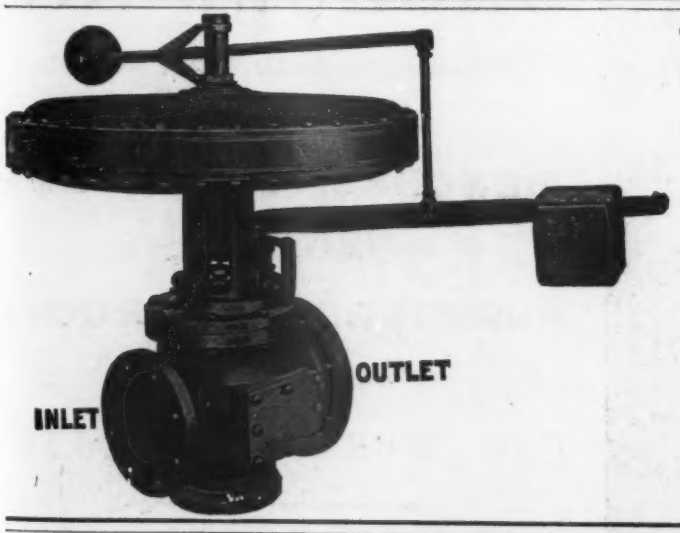

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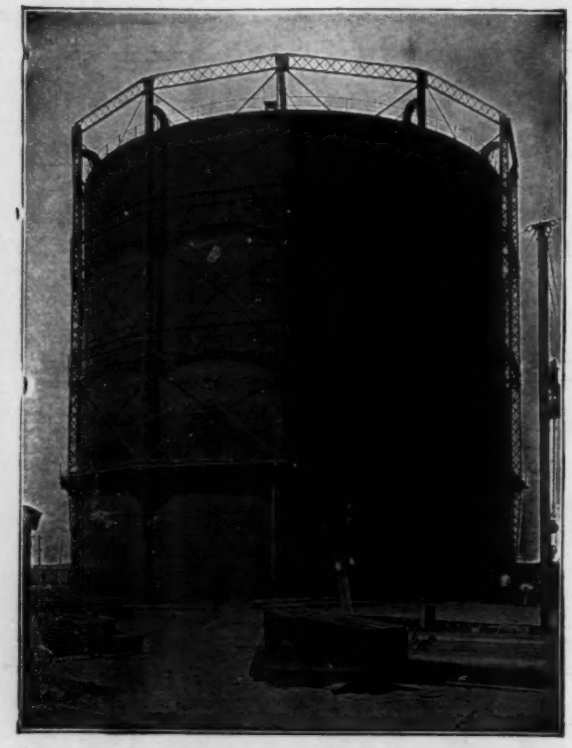

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